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These papers were presented at a Seminar on Industrial Aspects of Ophthalmology given by the National Society for the Prevention of Blindness in the Spring of 1944. They will be included, together with a number of others, and extensive discussion, in a 144-page volume, to be published by the National Society for the Prevention of Blindness under the title, "Industrial Aspects of Ophthalmology—Seminar Proceedings."

Importance of Industrial Ophthalmology

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CONSERVATION of eyesight should be an integral part of an industrial health program. Such a program should include more than prevention and treatment of accidental injuries to the eyes, for unrecognized chronic conditions of the eyes of employees and disregard for visual demands of particular jobs leave unremedied much that affects the health and efficiency of the worker.

An appalling picture is painted by Cozzens[1] when he states that industry in this country is losing or repairing 200,000 eyes annually at a yearly cost of $50,000,000, with 8,000,000 man-days being lost each year as a result of industrial eye accidents. He states, moreover, that 72 per cent of these accidents occur on supposedly nonhazardous jobs. Yet in a study made of 50 plants[2] employing in all over 165,000 workers, it was recorded that 98 per cent had safety programs and 94 per cent had safety supervision. If we may assume that these percentages are true of industries in general, then we must further assume that protection of eyesight through these safety programs has been inadequate.

Protective goggles against flying particles, fumes, and glare are being rather widely used but still not as extensively as they should be nor is the wearing of these devices sufficiently enforced. Protection against accidents is only one factor, however, in the conservation of eyesight. Diagnosis of eye defects and job analyses defining visual requirements are equally important factors.

Visual acuity, depth perception, muscle balance, color discrimination, all are qualities of perfect vision, but most jobs do not demand this perfection. A worker deficient in any one of these qualities may be sufficiently equipped for a number of jobs in a plant but be entirely unfit for work that demands particular visual qualifications. To place a worker with defective vision in such a job, without

proper analysis of his condition or of the requirements of the job, is to jeopardize the health of the worker and the quality of his work. Furthermore, eyestrain in a worker thus improperly placed, leads to early fatigue with decreased production. There is, therefore, double wastage, waste of manpower and of materials.

In addition to this waste, there is with such a disability, an increased liability to accidents. Dr. Kuhn,[3] in her recent book on industrial ophthalmology, states that in a survey of one year's lost-time accidents in a plant of 9,000 employees, it was found that these accidents had a direct relationship to visual defects. This is a serious condition, as Dr. Kuhn says, in industry "where less than top capacity production or unnecessary waste of critical material is almost sabotage."

I am sure that all these observations and many more in finer detail have been brought to your attention during this Seminar, and I repeat only to emphasize that the care of the eye should and must be included in our total industrial health program. We see practically every specialty of medicine participating in this work and correlating the findings (the latest to my knowledge is the psychosomatic group), so why neglect industrial ophthalmology? "The need for ophthalmologic service in industry is seemingly as great as is the acknowledged need for medical, dental, and nursing service" —to quote from Assistant Surgeon General R. C. Williams' paper.[4] One of the old slogans in promoting physical examinations of school children as part of the school hygiene program was "the whole child goes to school—his body as well as his mind." In like vein we can say a worker takes his eyes to the plant as well as the rest of his organic makeup of concern to the industrial physician. To cope with this problem an ophthalmologist must know industry, the hazards involved, labor-management relationships, and many other things of which the private practitioner has no knowledge.

If, as we have said, proper placement of workers with impaired vision requires an understanding of jobs that they can adequately fill, then the industrial ophthalmologist in addition to his thorough knowledge of vision and his training in treatment of eye diseases and correction of deficiencies of sight, must familiarize himself with the many jobs within the plant and their visual requirements. In co-operation with the medical department, it is his function to es-

tablish eye standards in that industry and advise in the proper placement of handicapped workers.

You know, as ophthalmologists, that eye conditions are often symptomatic of systemic disorders that may be remedied or may incapacitate the worker for the job he is about to undertake. The eye at times does warn of serious conditions present or pending. It is in the interest of both labor and management that these conditions be discovered. The ophthalmologist working in close co-operation with the medical staff of the plant has this valuable service to perform and has a selling job as well.

In every issue of the *Public Health Reports* of the United States Public Health Service, you will find the phrase "No health department, state or local, can effectively prevent or control disease without knowledge of when, where, and under what conditions cases are occurring." With like reasoning, no plant can effectively prevent or control the problems of industrial ophthalmology without knowledge of when, where, and under what conditions such problems occur.

A beginning in these evaluations is under way by surveys operated and sponsored by the National Society for the Prevention of Blindness, such as job analysis studies in Connecticut under Dr. Lo-Presti where 1,000 employees were examined; the survey of 20 additional plants from the point of view of eye care; the survey of eye conditions in 50 plants discussed by Mr. Tolman at the opening session; the Stevens Institute survey to demonstrate the value of a screening device; and the pioneer survey work of Dr. Hedwig Kuhn. In our program planning we have the backing of the Joint Committee on Industrial Ophthalmology of the American Medical Association, the American Academy of Ophthalmology and Otolaryngology, and the United States Public Health Service.

The United States Public Health Service, through its Industrial Hygiene Division, is prepared to give to industrial plants the benefit of its collected knowledge of industrial health, to advise and assist in making plant surveys with the co-operation of the State divisions of industrial hygiene and community agencies, and to assist in correlation of methods and findings. The Service has recognized the importance of eyesight conservation in industry by the participation of its representative in the survey now being con-

ducted and approves of the seminar now in session for the training of ophthalmologists in industrial medicine.

The field is wide and the demand for these trained professional men will be increasing steadily as management realizes the importance of eyesight conservation in maintaining the efficiency of the worker. The ophthalmologist giving part or whole time to this field of professional endeavor will find an interesting vocation and will make an immeasurable contribution to the war effort and to the reconstructive work that is to follow cessation of hostilities.

References

1. *Chemical and Engineering News,* January 25, 1944, p. 130.
2. Kuhn, Hedwig S., M.D. *Industrial Ophthalmology,* St. Louis: C. V. Mosby, 1944, p. 209.
3. *Ibid.*
4. *Industrial Aspects of Ophthalmology,* p. 231, below.

Responsibility of the Ophthalmologist in the Industrial Field

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IT IS generally acknowledged that the science of medicine and the application of such knowledge for the relief of human ills have made notable and continuous progress. However, despite these facts there still exists a gap between our scientific medical knowledge and its practical application to human needs. Though the quality of our medical practice has been said to be the highest in the world, there is just ground for criticism because of failure to reach all classes in its distribution. The medical profession is now giving careful study to this problem of establishing ways and means by which adequate medical service may be distributed to everyone.

These general observations apply also to the field of ophthalmology. Indeed, they are particularly applicable to that part of this specialty which relates to the vision of industrial employees to which our attention is directed at this time. The field of industrial ophthalmology is broad and complex. Its extent can best be shown by the fact that there are more than 45,000,000 industrial employees in the United States. All these should have at least some kind of pre-employment visual examination. In addition many will require a complete examination, for the purposes of diagnosis of their visual defects, for correction, and for proper job placement. The magnitude of these simple steps is indicated when we consider that there are only 6,000 physicians practicing ophthalmology including 4,000 who practice eye, ear, nose, and throat. This indicates that if we could divide this number of patients equally among all of us, each would have 7,500 industrial patients to examine immediately. The complexity of this field is shown by considering the fact that in addition to the examinations there is the care of eye accidents, institution of programs for their prevention, medico-legal

DISTRIBUTION OF EYE PHYSICIANS AND OPTOMETRISTS IN RELATION TO INDUSTRIAL WORKERS, BY STATES

State	Number of Ophthalmologists*	Workers per Ophthalmologist	Eye, Ear, Nose and Throat Practitioners†	Workers per Practitioner	Number of Optometrists‡	Workers per Optometrist	Industrial Workers
Alabama	7	113,406	67	13,341	140	6,384	893,848
Arizona	5	30,034	21	7,151	37	4,058	150,173
Arkansas	3	194,648	36	16,220	104	5,614	583,944
California	150	16,835	292	8,648	1,432	1,763	2,525,281
Colorado	30	11,658	49	7,137	193	1,812	349,735
Connecticut	34	20,015	56	12,152	245	2,740	680,490
Delaware	2	51,314	11	9,330	30	3,421	102,627
District of Columbia	39	7,921	80	3,861	94	3,286	308,900
Florida	12	56,944	75	9,111	153	4,466	683,333
Georgia	10	110,741	77	14,382	168	6,592	1,107,412
Idaho	4	39,652	18	8,811	67	2,367	158,606
Illinois	127	22,633	322	8,926	1,868	682	2,874,431
Indiana	32	35,991	136	8,469	429	2,684	1,151,703
Iowa	17	50,752	141	6,119	382	2,258	862,781
Kansas	11	53,075	81	7,208	302	1,933	583,826
Kentucky	15	56,505	79	10,728	232	3,653	847,563
Louisiana	22	35,052	58	13,070	195	3,954	771,142
Maine	17	16,413	24	11,627	140	1,993	279,036
Maryland	31	22,287	49	14,100	153	4,430	690,911
Massachusetts	88	17,440	141	10,885	884	1,736	1,534,787
Michigan	54	33,795	186	9,812	706	2,585	1,824,953
Minnesota	28	33,268	121	7,698	425	2,192	931,499
Mississippi	3	242,485	48	15,155	88	8,266	727,455
Missouri	76	17,067	91	14,254	708	1,832	1,297,094
Montana	4	46,391	26	7,137	68	2,729	185,564
Nebraska	16	27,089	55	7,880	230	1,884	433,427

* Certified ophthalmologists.
† As listed in the *Directory* of the American Medical Association.
‡ As listed in the *Directory* of the American Optometric Association.

DISTRIBUTION OF EYE PHYSICIANS AND OPTOMETRISTS IN RELATION TO INDUSTRIAL WORKERS, BY STATES (*Continued*)

State	Number of Ophthalmologists*	Workers per Ophthalmologist	Eye, Ear, Nose and Throat Practitioners†	Workers per Practitioner	Number of Optometrists‡	Workers per Optometrist	Industrial Workers
Nevada	..	..	4	10,116	19	2,182	41,462
New Hampshire	10	17,599	21	8,381	98	1,796	175,999
New Jersey	53	29,605	110	11,264	651	2,410	1,569,059
New Mexico	1	140,269	15	9,351	36	3,896	140,269
New York	412	12,074	259	19,168	1,764	2,820	4,974,518
North Carolina	12	1,007,724	84	14,389	148	8,167	1,208,690
North Dakota	3	66,798	27	7,422	60	3,340	200,396
Ohio	90	26,055	232	10,108	1,114	2,105	2,344,967
Oklahoma	9	73,193	99	6,654	206	3,198	658,739
Oregon	8	48,733	64	6,091	129	3,022	389,798
Pennsylvania	236	13,687	255	12,667	1,578	2,047	3,230,167
Rhode Island	5	52,945	11	24,066	120	2,206	264,723
South Carolina	2	330,536	42	15,740	88	7,512	661,073
South Dakota	2	102,257	17	12,030	80	2,556	204,514
Tennessee	14	67,265	77	12,230	218	4,323	941,714
Texas	47	45,496	260	8,224	651	3,285	2,138,355
Utah	7	21,269	31	4,803	58	2,564	148,886
Vermont	1	125,092	18	6,950	167	748	125,092
Virginia	23	40,567	88	10,692	157	5,943	933,058
Washington	21	28,936	92	6,604	239	2,543	607,672
West Virginia	9	57,677	66	7,865	106	4,897	519,094
Wisconsin	15	70,717	145	7,316	432	2,455	1,060,758
Wyoming	2	43,279	5	17,312	26	3,329	86,559
Total	1,819	..	4,363	..	17,618	..	45,168,588 Working population in U. S.

* Certified ophthalmologists.

† As listed in the *Directory* of the American Medical Association.

‡ As listed in the *Directory* of the American Optometric Association.

service, the consideration of all matters relating to the conservation of the vision and of rehabilitation of the injured. Such a complete service by ophthalmologists is physically impossible and it is not practicable or necessary, as satisfactory preliminary or screening tests can be made by instructed or trained personnel which will eliminate those who have standard vision.

Many surveys have been made which indicate that on the average about twenty per cent of industrial employees have defects of vision sufficient to be a handicap to efficient production. These can be screened out using some practicable method of screening by laymen. This method will make it unnecessary for the ophthalmologist to examine the 80 per cent having standard vision. If one third of all ophthalmologists were practicing ophthalmology and these should care for the defective 20 per cent, each ophthalmologist would still have 4,500 industrial patients to care for. Compensible eye accidents alone are 300,000 per year. These observations and data indicate the scope of visual service which industry requires. And despite the extent of this field and its complexities, in accord with the best medical traditions and principles of the ethics of the medical profession, the responsibility for rendering adequate ophthalmic service to industrial employees should be assumed and all difficulties should be overcome.

In the past, the field of industrial ophthalmology has been neglected, but the needs in this field have been given serious consideration recently, and progress is being made in the development of a better service. It might be profitable to point out briefly some of the underlying causes for this neglect.

First: As pointed out above, one of the causes is the lack of sufficient ophthalmologists, but many could give more service in this field than they now give.

Second: The neglect has an economic phase in which employers, employees and ophthalmologists are concerned. From the economic point of view, each of these groups has generally assumed the following attitude: (a) Employers have not been willing to assume all the cost incident to pay for loss of time which is necessary for making eye examinations at the office of the ophthalmologist, nor for the cost of many ophthalmic supplies, such as goggles and corrective lenses and their mountings. In many plants the cost of

establishing and maintaining a medical staff or even a first aid service has been considered prohibitive. (b) Employees have not been able to bear the expense of proper care of their eyes. (c) Ophthalmologists have not assumed their share of the problem of finding ways and means for bringing their services within the economic sphere of both employers and employees. Such problems demand our very careful attention. Points of view of all relating to cost and to methods must be adjusted by compromise.

Third: Ignorance on the part of many employers of the importance of good vision in productive efficiency, in prevention of both eye and other bodily accidents, in the maintenance of good health both ocular and general, and of the value of good vision on the contentment and happiness of employees. Employees also often are not aware of their visual defects and of the possibility of their correction. The ophthalmologist has not yet learned the most practical method of giving the most useful service to industry or what constitutes adequate service to industrial employees.

Fourth: There is some indifference on the part of all three interested groups. Industry is often not sufficiently interested in the visual welfare of its employees; employees often have an indifferent attitude towards proper or adequate care of their eyes; and ophthalmologists are often indifferent to the visual problems of industry and its employees. There is a tendency on their part to cling to old and conservative methods of practice, and an unwillingness to meet the reasonable demands for change in methods of practice. Although there could be much saving of time of the employee if the ophthalmologist would make provision for rendering ophthalmic service at the plant, he still wishes to confine his practice to his office. Educational programs which are suitable to each of these groups would overcome some of this indifference.

From a consideration of some of the fundamental causes which underlie an inadequate ophthalmic service in the industrial field, as mentioned above, it is evident that the establishment of a more adequate service will require the co-operation of all three groups who are interested in and responsible for such service. But in introducing this seminar the attention of the ophthalmologist only is directed to an outline of some of the phases of industrial ophthalmology; and his attention is called also to his obligation and

responsibility for a more adequate service to meet the demonstrated needs in this field.

Visual conditions as they exist in industry today have been surveyed in a number of different types of plants and these make a good cross section pattern of such conditions in the country as a whole. Many of the pertinent facts of a recent survey will be presented by Mr. Tolman. Other surveys have been made by Drs. Tiffin, Kuhn, and others. From all of these data the ophthalmologist is able definitely to understand the needs for a practical and adequate ophthalmic service in industry. From this data, we find that the treatment of eye accidents is of high grade, that the protective program, especially the use of goggles, is excellent in most plants, but there is still room for improvement. This program could be improved by more careful fitting to the individual and by using those types most suitable for the specific jobs. Correction of refractive defects is largely neglected. First aid, largely by the employment of trained nurses, has been greatly extended during the past few years in the larger plants; but the smaller ones are still neglected. In most of these smaller plants all phases of ophthalmic services are lacking.

By way of introduction to those present in this seminar, and in order to outline the scope of desired activities in the industrial field, let me list some of the aspects of practice in which the ophthalmologist should have special knowledge or interest, and in which he should participate. But first, let me state parenthetically that every industrial ophthalmologist should make it his duty personally to visit and inspect the visual demands of any and every plant with which he has any association. Very much more can be learned of the visual task in this way than by merely getting a history of any industrial operation. Some items in the following listing have been indicated above but may be repeated for sequence of ideas. This list of desirable fields of activity follows:

1. Aid in the establishment of a medical staff. An ophthalmologist should be included—full time, part time or as consultant.
2. Establishment of a system, or method of testing the vision of pre-employment applicants and of all employees. The latter is best accomplished by some approved screening method. Provision should be made for rechecks at stated intervals.

3. The development of suitable records. These should contain all data obtained from the individual's history and from all tests and examinations. These tests should contain data which will aid in the proper placement of all potential or present employees.
4. The establishment of suitable programs for examining those found to have subnormal vision, for correction of these when possible, and for furnishing the indicated supplies.
5. Institution of protective programs and methods for their continued application.
6. Establishment of first-aid stations. This requires special equipment for examination and for treatment of eye injuries. A nurse specially instructed or trained is most suitable and her services are most valuable. All activities of the nurse should be under the direction of an ophthalmologist.
7. The study of adequate illumination.
8. The study of occupational lenses. The demands made on vision by modern industry vary greatly with various types of employment, so that the industrial ophthalmologist must consider more than securing the best visual acuity at 20 feet or at 14 inches. Some types of employment require good vision within the usual 14 inches. Still others require good vision at these and all intermediate points.
9. Assistance in placement. Visual ability or skill is not possessed at a maximum degree by all employees, even with the best correcting devices. Therefore, the ophthalmologist should indicate to the placement personnel, those jobs which are suitable to the best obtainable vision of each employee, keeping in mind efficiency and the risk of injury to his other organs or to other persons. This implies a huge task of job classification.
10. Consideration of all the special problems connected with any specific employment. In some occupations color vision is essential; in others skill in color discrimination is required; and in others good stereopsis (depth perception) is necessary.
11. Study of problems of the relation of vision to general health and vice versa. These may include problems of ventilation, of posture, of nutrition, and of domestic and social relations.
12. Rehabilitation of those sustaining eye injuries by finding suitable jobs for these after proper training.
13. Giving aid to problems relating to vision in the medico-legal field which requires expert knowledge of the compensation laws of the several states, and the computation of the degree of visual disability resulting from injury.

In general, the industrial ophthalmologist, in addition to his specific fields of activity, must consult and co-operate with management, placement personnel and medical staff members on many problems which may arise in any plant. And finally, in order to meet the needs of industry and to close the gap in a neglected field of ophthalmology, the industrial ophthalmologist must understand the best methods by which he can serve the visual needs of industrial employees, and he must assume the responsibility for rendering the complete and adequate ophthalmic service both to industry and to industrial employees.

Industrial Aspects of Ophthalmology

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THE Seminar on industrial aspects of ophthalmology now in session in New York City has as its worthy objective, the arousing of interest of ophthalmologists in the eye problems in industry, emphasizing: (1) a need for an adequate eye conservation program, (2) the lack of a sufficient number of industrial ophthalmologists to carry out such a program, and (3) the necessity for increased instruction in industrial ophthalmology in medical schools.

The need for an eye conservation program in industry has increased with the demand for more and more workers and also with the utilization of handicapped persons formerly rejected as unfit or undesirable in industrial jobs. Potential employees with correctable eye conditions, or with defects that should not disqualify them for certain jobs, were formerly ruthlessly refused industrial work—partly because of compensation costs that might result. Today with a demand for every available worker, it is the problem of industrial ophthalmology to select the jobs suitable to the visual ability of workers, in order that they may contribute to the war effort. Above all, it is the responsibility of the industrial ophthalmologist to conserve the eyesight of every employed person.

To what degree spoilage of materials, industrial accidents and absenteeism, due to eyestrain or eye diseases, may be lessened, can be determined best by the industrial ophthalmologist. Correction by proper lenses, muscle exercises and other devices, is but a part of the problem. Both analysis of the job to determine the visual requirements of the employee, and corrective measures to give a visual acuity as nearly normal as possible, have been neglected factors in most industries. Eye hazards in industry, on the other hand, have had proper consideration and extensive thought has been given to the use of protective goggles. However, according to a survey of the National Society for the Prevention of Blindness, it

was found that in 50 plants employing a total of over 165,000 workers, only 70 per cent of the plants fitted goggles to the workers, and, moreover, the wearing of these devices was not generally enforced. Even in so-called non-hazardous jobs, the fact that so many goggles are broken, indicates a need for their constant use. Enforcing the rule to wear goggles is the responsibility of plant officials; educating workers to appreciate their value can well be the function of the ophthalmologist.

In addition to job analyses to fit workers into jobs adapted to their visual ability, to the prescribing of proper lenses, and to treatment of eyes after industrial trauma, an industrial eyesight program must include diagnosis of general diseases with eye manifestations. These diseases include cardiovascular disorders, blood dyscrasias, brain tumors, syphilis of the nervous system and various other conditions that affect the blood vessels of the eye. Specific diseases of the eye such as trachoma, glaucoma, iritis and many other pathologic conditions should be diagnosed in pre-placement examinations or in periodic re-examinations.

The results of a survey to determine the status of eye conservation practices in industrial plants, conducted in 1942, have indicated the acute need for ophthalmologic services in industry. Although 98 per cent of the plants surveyed have safety programs, with 90 per cent having safety education of employees and 90 per cent medical supervision, only 24 per cent have job analysis with industrial visual requirements, and only 20 per cent have visual examination of the eye made with binocular instruments. In reporting of accidents, only 22 per cent of the plants included eye tests of those involved and 12 per cent considered the possibility of illumination as a contributing factor. These figures indicate the indifference shown in industry to eye conditions.

The need for ophthalmologic service in industry, therefore, is seemingly as great as is the acknowledged need for medical, dental and nursing service. The Industrial Hygiene Division of the U. S. Public Health Service has recognized this requirement in a well-rounded program for industrial hygiene. One of its medical officers, who is a specialist in this field, has been assigned to the headquarters of the National Society for the Prevention of Blindness to assist in the development and conduct of a program in eyesight

protection in industry. This is but a step in further development of co-ordination of industrial ophthalmologic service with other hygiene services now functioning in industry.

The general industrial hygiene program is directed toward decrease of illness and injuries, and the improvement of the health and efficiency of all personnel with a consequent decrease in costs to the worker and employer. If 60,000 compensable and 240,000 non-compensable industrial eye accidents occur annually in the United States, certainly conservation of eyesight must be a considerable part of this program and particularly if, as it is claimed, these accidents occur chiefly in foundry, machine tool and metal industries, all of which are vital to the war effort.

With the development of a program for eye conservation in industry comes the further problem of securing a personnel especially trained for this work. Not only has the number of available ophthalmologists been depleted by calls to the Armed Forces, but those in private practice, with few exceptions, have little knowledge of eye conditions in industry except as they have attended workers in their own offices. The relation of eye lesions to industry is not generally understood nor are the adaptations that may be made to continue the worker in his job. Use of the Snellen chart in the measurement of visual acuity is only one step in the eye examination of an industrial worker. Depth perception, muscle balance, color deficiency, all must be evaluated in determining the worker's ability to do a given job effectively and without injury to himself, to others and to the materials with which he works. He must understand not only the evaluation of normal and abnormal vision in industry, but the methods for conservation of eyesight in addition to prevention and treatment of eye traumas. He should be acquainted with industrial environmental conditions—illumination, toxic chemicals and gases; he should know something of compensation laws as related to injuries to the eye.

Industrial ophthalmologists have a greater responsibility than the removal of foreign bodies from the eye or repair to injured eyes and eyelids. They must confer frequently with management and other officials, with safety engineers and with the medical department. There must be close co-operation with the medical service in diagnosis and treatment of various eye conditions related to

systemic diseases. It is the function of ophthalmologists to establish eye standards in industry and to assist in the rehabilitation of those with injured or otherwise defective eyesight.

By no means does all this imply that full-time ophthalmologic service or complete ophthalmologic equipment is required in industry, except possibly in very large plants. Part-time service in conjunction with that offered by physicians and nurses in the plants usually will suffice. Yet even with only part-time service, the supply of industrially trained men will be insufficient. Ophthalmologists now in private practice may obtain practical information by attending seminars such as you are attending tonight. Medical schools should give greater emphasis to the teaching of industrial ophthalmology. Medical students may well prepare themselves for a career in this industrial field, now in its infancy, perhaps, but in war or peace, a constantly broadening one as its potential services are realized.

The U. S. Public Health Service, through its Industrial Hygiene Division, stands ready to assist in the preparation of eye conservation programs, to give consultant service through its ophthalmologists, its physicians and its engineers, and to further co-ordination of ophthalmological service in the nationwide industrial hygiene program.

Visual Job Analysis and Prescribing for Special Work Distances

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IN order properly to refract and prescribe for an individual operating any kind of machinery, it is essential to become thoroughly acquainted with the specific mechanics involved. If one's relationship is that of ophthalmological consultant to an industry or industries, it is highly recommended that a careful visual job analysis of the entire plant be made, using a work sheet.* The operations, job numbers, and departments can be entered on those sheets prior to going through the plant; and it is well to go through with someone thoroughly familiar with all operations. By use of a check on this analysis chart (which of course can be revised or changed to suit individuals or special needs) it is possible to note, as inspection is being made, the most important items. Details can be filled in afterward.

Any one of several visual functions may be important on a given job. If so, each one should be checked. Important among these are the following: (1) Distance acuity; (2) near acuity; (3) distance muscle balance; (4) near muscle balance; (5) color; (6) stereopsis; (7) multiple work distances; (8) illumination; (9) work in motion or not; (10) hazards if any, such as glare, foreign bodies, fumes, flash, etc.; (11) are bifocals permissible or not? and (12) what degree of perfection is required—perfect, fair or poor?

In addition to checking these factors and others of particular interest, it is important to make marginal notes of anything that strikes the inspector at the moment. With this sheet, he can then sit down and thoroughly acquaint himself with every job and its name. Whether a refractionist is placed in that plant or these people are refracted for industry in the doctor's private office or they are refracted as private patients, the inspecting doctor has

* See page 236.

SAMPLE CHART
VISUAL JOB ANALYSIS

COMPANY NAME ______________________ DATE........................

CODE √ = Important
√ √ = Essential

DEPT.	OPERATION	JOB	Distance Acuity	Near Acuity	Dist. Muscle Bal.	Near Muscle Bal.	Color	Stereopsis	Class A—Perfect	Class B—Average	Class C—Def., OK	Bifocals, OK	Bifocals, Bad	Illumination	Tint Advisable	Work in Motion	Glare Factor	F.B. Hazard	Fume Hazard	Splash Hazard	Infra-red Hazard	Ultra-violet Hazard	Work Dist. Multiple	Etc.
27	Drill Press	70	√		√					√				√				√					√	
14	Spot Welder	24	√			√				√					√		√ √				√ √	√ √		
16	Inspector	14	√	√ √	√	√ √			√			√		√										
60	Labor	39	√								√													
18	Crane Operator	24	√		√			√	√					√									√	

acquired a thorough understanding of their work and the demands made on their eyes.

To illustrate various types of industrial operations—a gantry crane operator in the shipyards, absolutely must have excellence of distance acuity and depth perception and normal distance muscle balance. The operator of a strip mill has entirely different things to do with his eyes. Here distance acuity is of great importance. There are gauges and dials placed at all levels, high over the operator's head, on the level with his eyes, and below eye level. When things work smoothly and normally, such a man is not in any difficulties as far as his eyes go. However, bifocals might definitely interfere with operators who need to act quickly in an emergency. I have seen this happen. Inspection of tin plate which has reflections and glare from the polished surfaces, requires excellence of *near* vision acuity and near muscle balance. An individual who reads a micrometer does so usually, only at intervals, during the day. Because figures of the scale are exceedingly fine and are usually read at eight or ten inches, the add required is entirely different from that ordered for the same individual in order to read a newspaper at the regulation reading distance of 14 to 16 inches. Each such case has to be determined on its own merits. In the corrected vision goggle, a solution has been offered in what is called a "flip up" goggle. Here the add is put separately in a little hinged attachment and brought down into position only when it is necessary. This leaves the distance a single vision lens for such operations as turret lathe, etc.

In general, inspecting of any type is one of the major and most difficult of industrial visual problems. For instance, bottles may approach an inspector on a conveyor belt moving from left to right. They are inspected through a large magnifying glass. The element of glare from a light which is often directed into the operator's eyes, the constant motion from left to right, the distractions which are usually not shielded from the operator—such as the moving belt—make for great fatigue. These girls inspect for 15 minutes or so only, at intervals throughout the day. They look for 14 or 15 defects in each bottle, and inspect as many as 80 per minute; so you can see what the visual problem is. The lathe operator has multiple work distances in the handling of his complicated ma-

chines. Many require precision setting and close watching. Wearing bifocals in some of these lathe operations can be a great handicap, although many operators do wear them with comfort.

An electrician needs both visual acuity and color appreciation—different wires being followed through an installation, on the basis of color. An electric truck operator, working inside of a plant, obviously needs good distance acuity and depth perception in order to guide a fast-moving vehicle through narrow lanes, as well as for picking up a load. In the inspection of gears of highly polished steel, excellence of near vision is essential. Present here, also, are the problems of glare and proper lighting. In a few cases, it may be advisable to use a tint in the lens, as, for instance, in the case of an especially light-sensitive person. It is not advisable, however, to use a tint for all inspectors of highly polished metal or for all people in any given department. Such general and indiscriminate use makes workers feel that there may be a hazard which is not actually present.

Fingerprint classifiers use a magnifying lens in one eye. Obviously, any type of ordinary glass correction would bear no relationship to this type of visual job. It will be possible some day to give these people binocular magnification of sufficient strength to do their work, without the strain imposed in doing it according to present methods. People reading blueprints have need of good near vision and of normal near muscle balance. The figures and lines are very small, blueprints are often tacked to a table, so that some of the distances are 14 inches, some 24, and some even 30 inches. Trifocals may be of assistance in this type of problem.

Small-parts assembly requires excellence of all near vision functions, and often also of color. In most instances, such work could be done with a much higher degree of comfort if special occupational glasses were prescribed. These would be left at the machine at the end of a work day. Here we may need to consider also, the height of an individual, whether or not chairs or stools are fixed, and what the illumination is, before prescribing. Overhead inspection, such as at the roof of a mine, brings up a new problem. Occasionally an upside down bifocal is helpful here. Illustrations were shown simplifying these statements, which it would be repetitious to discuss here.

Now I want to give you at least the general background of industrial defects, if I may, so that we have them in mind when we think in terms of refracting for a work distance.

The correction of visual defects of industrial employees is the number one assignment that ophthalmologists have. You already have been given the statistics of such defects, but we still must keep them in mind. There are five basic categories that we use: (1) *unaided acuity* (distance acuity without correction); (2) *working acuity* (which is the acuity of an individual with whatever glasses he is wearing, which may not be the best); (3) *muscle balance;* (4) *depth perception;* and (5) *color perception.*

Substandard visual performance, as shown in graph form, in ten industries, gives one an almost universal 15 per cent defects of acuity that do require attention. Visual defects among applicants in industry are close to the same percentage as that shown for those already in industry. This pretty well explodes the theory that industry produces visual defects through strain, or other causes.

The biggest stumbling block to the whole industrial program has been the question of keeping well-intentioned people from trying to correct almost everything. This is now done in the schools, where it has more merit, and where anything suspicious is best investigated.

If, in industry, you become so discriminating that you send out or advise to go out for correction, all people with defects of 20/30 vision, 20/40 vision, even 20/50 vision, per se, you may well flood the district with people seeking advice. In a highly industrialized area this can become a very awkward and topheavy procedure whereby you lose the punch, and risk the effectiveness of the whole program. Actually, when you boil it down, about 15 per cent are serious eye defects of one kind or another—that is, vision 20/100 or less in one eye, a squint, or a pathological condition. For color blindness, of course, there is no remedy, in spite of the cults advertising such cures. We have a big problem as it is, with the 15 per cent needing attention. In one plant of 10,000 employees, this meant 1,500 people whom the medical director had to interview himself. A man with a serious eye condition has the right to be seen by the plant medical department and to be told how to take care of it. Industry has become soured in many instances where

it was advised that everything should be corrected, little and big.

Undoubtedly we shall miss some serious eye defects among the screen tested "normals." We should like to do field of vision tests and fundus examinations on everyone; that is impossible now, but maybe after the war we can. We shall therefore for the present overlook some glaucomas, early brain tumors, optic atrophies, and retinal hemorrhages. But we certainly do accomplish a great deal by being practical—we do find and care for most of the serious eye trouble.

There is a marked difference between the percentages of eye defects as of 1940 and of 1943 among both payroll employees and applicants. The defects in both groups are much higher now, and we see clearly what our eye problem, from the standpoint of pathology and correction, has come to be. Among the applicants the rise is even more obvious than among those on the payroll of industry, because we are now practically "scraping the bottom of the barrel."

Percentages of visual defects vary in different types of occupation. In nature, the survival of the fittest has assisted in a sort of job placement program. One cannot be a crane operator and stick to that job unless one has the basic visual skills to do it. One may have an accident and be taken off, or one may not do one's work well enough, and be taken off. A foreman has to do a little bit of everything, therefore is shown to have a high record of all visual skills because he has *had* to be highly qualified to survive.

Statistically, we found the visual standards that we set for applicants for these jobs match closely those shown by nature's choice. Nature has thus supplied us with what the industrial psychologists and statisticians are now giving us as "predicted" performance.

It is important to say a few things about illumination at this point. We give a person glasses in order to make him see more clearly as far as his refractive error goes, but he does also have to have light. We need to know a little bit what the illuminating engineer can do to assist us. A welder is supposed to do an accurate job. But he does not have the light to inspect what he has done after the "flash" of his arc is off—then it is dark! This all has a

direct bearing on the ophthalmologist's understanding. It is one thing to refract a man so he sees with illumination, and it is something else to refract him for a prescription welder's goggle if he hasn't got the illumination. The complaint still comes to *us* so that we have to *know* in order to tell him why his glasses don't work. You have probably all read Luckiesh's article in which he talks about knowing something about what the degree of vision is *at the place of work*. In other words, we have standards of illumination for testing vision, with fixed number of foot-candles for a Snellen chart. That gives us our standardized medical-legal record.

We still need to know what that person's visual acuity is at his particular job. Believe me, it is very often very different. It does not follow that he has normal acuity at that job because he had it in your examining room. Unless we follow through and are able to suggest that he be supplied with the illumination in critical jobs, we have really undertaken only half of our responsibilities. Nor do we encroach on anyone else's territory—we are informed.

Great numbers of "flash" cases are due to the fact that a man *has* to take off his *goggles* (his hood is already off) in order to see what he has done, because at that moment the fellow next to him "strikes" an arc, and the unprotected man gets the "flash."

I want to tell one little story which drives home the importance of the private office as a source of proper or improper refracting for industry.

> Mr. and Mrs. John Doe have been our patients for a long time. Mr. Doe is a foreman in an industry, and we have prescribed glasses for him and his job long ago. Mrs. Doe has always been just Mrs. Doe, but now she also has a clock number. She is an inspector in a nearby plant. She has previously never been very co-operative about wearing her glasses, but it did not matter so much, actually. Now she is a brand-new type of patient. While she is still a private patient, her eyes, which were used for reading and sewing and playing bridge, are now used for sustained near work eight to ten hours a day. Mary, the daughter, came in because she had some difficulty passing the company eye test. She wanted to work in a plant and she couldn't read more than 20/100. She is very nearsighted. Her prescription will not be the same as you would put on her if she were just going to school and parties.

(Here the question of exact work distance is vitally important, as I will show a little later.) The same holds true for son George, who is highly astigmatic. He has never properly worn his glasses. Now he is in real trouble, even with his glasses on.

So you see that actually you don't have to go out to meet industry. Industry comes to you in just such problems as these, in which a whole family now have clock numbers and are workers and not drones.

The question of age in industry has added other entirely new problems of vision testing in industry. In comparison of visual performance in people over and under 40 years of age, we again see the tremendous increase in percentages of visual defects, this time in the mature age group. This is particularly true, of course, for near vision, and muscle balance. Incidence of muscle imbalances become much higher in people over 40 than under, especially if they are indiscriminately refracted and exophorias are created!

Professor Greenly, one of the great industrial psychologists, said, in a communication, that "it is worth while and necessary to survey our visual problems and to evaluate them, but it is even more important and appropriate these days to work out some kind of visual improvement, and with older workers the needs for such a comprehensive visual program have been very greatly heightened."

In our personal life we have an opportunity to vary what we do. If a housewife gets tired of reading, she can go shopping, or make a cake, or play cards; constantly, all day long, the work distances and play distances are varied. When we go into industry we have to do our job, which may be a single concentrated effort, and carry it on for eight consecutive hours. There is often need for constant, focused visual application; if the employee is unable to do this, he is out of luck and so is industry.

Working distances for exacting jobs are variable and the side effects are multiple. For instance, bench workers are people whose work is quite close and exacting, such as grinding or assembling small parts. The urgent need for seeing reflects itself in their posture. In one of our plants the bench workers and the precision workers were found to be sitting in every conceivable position. Some were up on top of their work, some were back and away from it; some had it in their laps, while others held it out in front of

them. They had their personal glasses on. As soon as these were changed and each worker was corrected for his work distance, these same people assumed natural and relaxed postures. The resulting comfort from having the glasses adjusted to work distances reduces absenteeism as well as irritability.

In a plant that makes gas masks, 200 operators were using sewing machines. There was a conglomeration of every shape and size of human being imaginable, each with a fixed work distance, in so far as chairs and furniture went. Here would be a tall woman, and she was bent down to her work; next would be a short woman leaning back from her work; here was one with her head at an unnatural angle. The first-aid station of this department was filled with women complaining of headaches, and the rate of absenteeism was up. As soon as the occupational lens distances were worked out, all of this disappeared. The same is true of workers on the small parts assembly, and of loopers.

When we speak of an "occupational" correction, what do we actually mean? We mean that we are attempting to restore the normal visual relationships which are disturbed by abnormal work distances. In other words, in our everyday life we usually work at 14, 16, or 18 inches for close work, while in industry it is often necessary to work at eight inches—for some operations at even six. That produces abnormal mechanical relationships of size of object and extra-ocular muscle effort. Therefore, what we do in ordering occupational correction is to attempt, by magnification and prisms, to correct to normal relationships of seeing. By the way, it is important never to imply, when conferring with management of such an industry, that the work a girl is doing at six inches is harmful to her eyes, and that we think she should get glasses to *protect* herself. This is not true. As soon as one implies an injury, one has created a hurdle for oneself in the psychological handling of management and labor. What we actually do is to suggest that she wear special occupational lenses, which, being really an optical aid (like a microscope) restores the normal physical relationships.

Nor does the worker have to be over 40 to have special near vision jobs. This we all know. One can be hyperoptic or astigmatic, and have a near vision difficulty at any age. Workers etch at six inches while others draft at 30. Also, we must take into consid-

eration all of the physical movements of the person for whom we prescribe. Does he climb on high scaffolding? If he does, do not give him a bifocal! Does he have to watch fast-moving steel in order to pick up defects as it *moves?* Is his inspection at eye level or above? Does he have a combination of work distances? On a line of ten lathe operators not every operator may need to do the same thing. Two may use a micrometer at intervals during the day—the other eight may not. If a lathe operator never uses a micrometer, and his machine is entirely automatic, with no need to test or inspect anything, do not prescribe bifocals for that operator. Giving these people the proper prescription depends on knowing all the factors of the job.

It is important to know when prescribing, whether there is excessive glare and whether it will need to be corrected by using a tinted lens. It is important to know whether the person is short or tall in relation to his machine. In fact, for some of the critical jobs we may need to go out to the plant, find the person and be sure all is well for him as an individual, at a specific machine. A different amount of plus often is needed for an eight- to 12-inch distance, than for a 14- or 18-inch distance. But if just plus is prescribed and then we sit back and say, "Now he can see," we get our patient and ourselves into real difficulty. We must make phoria measurements, to know whether that person has an exophoria to start with. He may not have a phoria for his usual reading distance, but the same man may have a marked phoria at the lesser distance of eight inches. Among 200 loopers in one plant, working at eight inches, 60 per cent of the girls had normal phorias at 14 to 16 inches. But of those who did have normal phoria measurements at 14 to 18 inches, 40 per cent jumped to an exophoria varying from 24 to 30 degrees at eight inches work distance! If someone needs plenty of plus to see, he may require a prism (base-in) and he may also need training—orthoptics. In the presbyope you have the same sort of thing, except that the range is more fixed because the lens has no elasticity.

Refracting and prescribing for the myope must also take working distance into consideration. Here I shall tell you an interesting story that illustrates this whole picture.

> A textile plant employing loopers had a very excellent ophthalmologist. Management, knowing there was an eye prob-

> lem, sent all their girls over to him for refraction. He refracted them in his office. Many of them were kids—16, 17, 18 years old. Many were myopes and had never before worn any glasses. He took their Snellen chart readings, and refracted them, prescribed their *full* myopic correction and told them never to take their glasses off. You can imagine the rest! Attempting to operate at an eight-inch work distance with their full minus correction threw them and industry into a real tailspin. It was only because this ophthalmologist had never been inside the plant, and had no idea what the girls' work problem was, that this happened. Instead of assisting either the girls or industry, he did them a disservice and pretty nearly upset the whole program.

There are many myopes, who have never worn a prescription, who are difficult to prescribe for unless we know pretty much what their job is. May I here indicate my strong personal aversion to prescribing bifocals for young myopes—it is never necessary.

The question of correcting astigmatic errors for people working in industry is one in which I think most of us get our gray hair. We have to remember not the textbook, not the theory, but *the job* and the hours and the fact that humans are cogs in a "must" production effort. If a man has never worn corrective glasses, has normal vision, and is doing drill press work or something that does not have to be ultra-exact, we may be able to put on a full astigmatic correction. But we are going to have trouble with some jobs and we cannot help making a few mistakes in order to get the "feel" of each particular job before ordering a specific correction. If a man is young and able to adapt himself, it is worth attempting full correction and telling him in advance that if he has too much trouble, his prescription may need to be changed. But we must remember that when you prescribe a change of axis or a full new astigmatic correction for a man who works ten hours a day, six days a week, he has little time to "break in" his glasses. In cases where he has been wearing a wrong axis, has normal vision, and is on a blueprint job, for instance, a change in axis may throw him entirely off. The blueprint lines are different, they slant, and are distorted, as we all know. Ordinarily, this man could take the hurdle and adapt himself to the change, but he often cannot with the pressure of management and the production committees behind him, to turn out work, turn out work, turn out work! One has to

be very, very practical in making such changes. If such a man has normal vision and is doing the job well, don't change his axis just because you know it is theoretically wrong. Maybe later it can be done. But if his vision can be improved from 20/40 to 20/20, one has to take a chance and hope that he can make the necessary adjustment. It is important to identify and institute a follow-up system for these cases, as you will find them prominent among your "grief and trouble" cases (as we call them). These, if any, are the cases we need to go out and find in the plant in order to try to iron out their troubles.

Also, there are people who have great refractive differences between their eyes. One eye has a vision of 20/20, and the other 20/200. Glasses have never previously been worn. If, for instance, we immediately prescribe a minus 3.50 in the one eye and no correction in the other eye, we have created an element of distortion. Few individuals can "take it." They won't wear their glasses, and they will have plenty of trouble and make plenty of complaints. A whole plant program may be jeopardized by our being a stickler to academic procedures. Instead, such a person can be left uncorrected and put in a monocular job—at least "for the duration."

When we discuss bifocals, we enter another complicated phase—often industry would rather have people who have lost a leg than somebody who is *visually* not qualified to work or who must wear bifocals. Bifocal cases are not only a literal headache to themselves but are often a headache to the ophthalmologist. They present also our greatest challenge! The practice "compromise" lenses are very bad. To me it has always been an indication that a lazy refractionist does not want to bother teaching a person how to use a bifocal, does not want to have him come back for adjustments and attention, and, to avoid these, prescribes an in-between glass—a little too strong for distance and a little too weak for close use. About ten per cent of the workers in one plant had compromise lenses, and these are the people that are really in trouble and caused us trouble. They claimed they were perfectly comfortable with what they were wearing. Their glasses were to them like an old shoe. Actually they could not see anything properly. Why not conscientiously attack the bifocal problem, assist people in learning how to use them, and make sure that they have the proper type of bifocal.

The need for concentrated effort, and the long working hours, add to our difficulties. Actually there are some *really* old people in industry these days! For instance, I saw many white-haired ladies making radar equipment. Unusually complicated near work is often a problem for which there simply may be no solution except to change jobs. This is where job placement enters, and where the proper evaluation of industrial visual skills prevents such difficulties.

The mechanics of a bifocal is also something that most of us have not paid enough attention to. We have left too much to the optician at our elbow. In industry we must be able to tell management, "This man should have a Kryptoc, and this one an Ultex." Inspectors usually do well with a pretty generous Ultex segment, as it allows plenty of room and prevents an aching neck. Other jobs do better with a Kryptoc. We need to know something about taking interpupillary distance, so as to emphasize its importance later in dispensing. We need to know what proper decentering is and its importance. We need to know about the "upside-down" segment, and how valuable it can be in cases where there are high dial readings or overhead work. Even nose and throat doctors must use an "upside-down" segment for their occupational correction! We need to know something about frame measurements and adjustments. Very few of the optical people themselves that go into the industries and dispense prescription goggles (especially bifocals) really know how to adjust a frame, or to tilt it so the wearer does not look under his goggles, thereby getting all the rim distortions of a heavy lens. Here is one place where I find the optometrists are far ahead of us; they usually do know how to do these things and do them expertly.

The flip-up goggle has been a solution to some of the headaches of bifocals. A man who has to read a micrometer, but only two or three times during the whole day, has multiple work distances the rest of the time. By putting the necessary plus in the flip-up, he can, when he needs to read the micrometer, just drop it and lock it. Then when he is through and wants to go on with his lathe work he just touches the little spring on the side and it flips up out of the way. The same thing can be done with a tint for heat treatment work, as it is only a few times during the day that a man actually "pulls" a heat. The worker may want a tint for this, and then only,

so for the rest of the day the tint would interfere. The tint then can be put in the flip-up.

The use of all-plastic frames for bifocals is a practice of which I personally am becoming increasingly critical. We have a shop in our own clinic, and our boys are not permitted to dispense bifocals in plastic frames without the doctor's approval. If a person has already worn a plastic frame with comfort, we sometimes make an exception. But if one has to make adjustments (raise or lower or tilt) one is stuck—one cannot adjust a plastic frame! Often people ask for this kind because they are supposed to be comfortable; the frame may be, the lenses and seeing are often not.

When not to order a bifocal is as important as when to order one, of course. Early in developing an eye program with management, we must make the decision that a crane operator is not to wear a bifocal. Stick to that decision, and do not let management talk you out of something that you know is right. Also, do not lay down rules unless, and until, you are sure of what you want. The same is true for electric truck operators, who tell you they have to read orders. If they have to read orders and need an add, they too can use the flip-up or clip-ons. Bifocals and an electric truck going at the usual speed down the narrow and dangerous aisles of the big plant is not a good mixture. The sweepers in one plant raised a fuss because they were not given bifocal lenses in their new goggles. They could not read their newspaper at lunch hours! Management simply told them they were not buying prescription goggles for them to read their newspapers. This differentiation between the use of an occupational correction and a personal correction needs constantly to be emphasized.

My good friend, Harry Guilbert, who has done so much for goggles safety in this country, let the "cat out of the bag" on one thing, when he said, "our goggles are so comfortable that the men wear them home and use them all the time." Perhaps, before industry began to get so many presbyopes, people over 40, this could be proper sometimes. Such a practice now actually means just copying the personal prescription. Sure, they can read the newspapers with this, but who knows whether they see their work? The fact that they *are* using the same prescription for everything is the very thing we are trying to get away from.

The proper use of near-point data is something that ophthalmologists have too often overlooked—they have overlooked it in private practice and in private refracting, and they are overlooking it in industry. Here it is even more important now than ever. The near point of convergence (n.p.c.) and the near point of accommodation (n.p.a.), the degree of exophoria, the amount of ductions, all are essential measurements. Inquiry into whether the person has a low hemoglobin or low blood pressure or toxic foci, is important. There is a close relationship between muscle imbalances and any one or all of these depleting factors. We had noted this very vividly in our office, where we do considerable adult orthoptics. Our cases always responded more successfully if we were sure at the start that they have normal hemoglobin, normal blood pressure, and no toxic factors to handicap them. Occupational orthoptics, as we have called it, is just as much in order as a corrective procedure as is the prescribing of glasses, for certain jobs. Squad car drivers in Illinois are required to have a so-called 100 per cent depth perception. Of course, there is no such thing as percentage of stereopsis—the whole scale of percentages is a false concept—but applicants are told they must have 100 per cent, and find that a printed regulation! So when they come in with a so-called 80 per cent stereopsis, they can be trained, through orthoptic procedures and, usually, brought up to the necessary 100 per cent. A looper who has an excessive exophoria can, through orthoptics, overcome this so she can do her work, and do it well. Inspectors and assorters are in the same group.

Actually, the salvage potential achieved through careful refraction alone, is very great. That type of salvage often requires refracting at the plant itself. In one precision plant, where the visual standards are necessarily high, every applicant not measuring up to these standards, would be lost if he were not refracted the same day at the plant. Thirty per cent of the applicants at this plant had visual defects that brought them below standard. It had already been proven that these people never returned if they had been told to "go out and get a pair of glasses and come back," as they always could get a job somewhere else without bothering with glasses. We had to refract in that plant on the day that the applicant registered. A breakdown of one group of 35 of these rejects showed that:

18 moderately below standard were brought to normal; 10 with serious defects would have been altogether rejected, but were brought to normal; 7 were rejected. In other words, 28 out of every 35 applicants otherwise rejected were salvaged each day. This plant grew from 2,500 employees to 6,800 in a year and a half. This is a salvage of human beings by nothing else than proper and plant-based refraction.

Ophthalmologists cannot do all of this refracting; we know that. What we have done in several plants, and what is being and will be done elsewhere, is to have a competent optometrist work with us. A qualified refractionist, trained especially for this type of work, is put on our payroll, not industry's; he is in there to refract, and that only. He carries out the policies and recommendations of the medical department. He studies and analyzes problems and brings them to us. He does not carry the responsibility of deciding *why* a person does not see, if not brought up to normal acuity with glasses. That is *our* job as medical people. I think that the time is coming—in fact, it has come—in which we shall need and want to have well-trained refractionists work with us in our private offices, and in our industries when it is necessary to refract at the plant. We ourselves need to carry the full responsibility of detecting all pathology, to take the overall charge of program, and sometimes to guide expert optometric assistance in refracting. Brickbats usually fly when this solution is suggested, as it is still an unorthodox one, but nevertheless it is a proper one and a necessary one.

In the matter of eye protective equipment, we share the responsibility. Prescription goggles are not a commodity; they are not like safety shoes or asbestos gloves. They are something that has to do with seeing. We need to know for ourselves and to emphasize it to the safety department (which usually handles the equipment or has charge of its care) that goggles must be adjusted individually. We need to impress management that someone has to go up and down the aisles with a service cart; that such an individual needs special training in order to dispense and to make the necessary adjustments at the operator's machine. If one is asked to lay out a goggles program (prescription goggles and regular plano goggles) it is well to insist on proper servicing; without it, the whole program may break down. One sometimes has to be with the dispenser when

he adjusts goggles at the machine. I spent almost three hours at different intervals with one man on a very complicated job, who was having trouble with his bifocals. It took special adjustments, it took changes of illumination, and it took effort and understanding to help that man.

The salvaging of goggles needs stressing. We should know something about custom-built frames for the man who has a broken nose or no nose (as we have had in two or three instances). These, too, are things that a safety man cannot handle. They are a combined medical and optical house problem. Proper interpupillary distances in goggles, as well as in occupational glasses, is one item with which we have also to be concerned.

Now let us discuss one of the most difficult of all close vision work problems—the proper occupational correction of loopers. A very curious thing happened when we sent the photographer to get a picture of a girl at a looping machine. A girl looping, actually is working at eight inches. Management was jittery about having anybody see a picture of a girl working at eight inches! Someone might assume that such work was injurious to the eyes. Then they would have labor trouble, maybe a strike! So when the photographer was around they were very careful to have the girl back away from her work and not be photographed at the real eight-inch distance!

This incident shows how badly we need to convince and reassure management. One does not have to be jittery about close work. We must help management solve these problems. If we don't help them, they have got every right to be jittery. Loopers have to put little prongs through the individual loops on hose. If they drop one stitch, they have spoiled the hose, which is later rejected. There are some 200,000 loopers in this country. They almost all do piecework. Their pay envelopes and their production rate depend entirely upon their accuracy at their work. Their accuracy depends on their eyes. So it was very important to do something to help these girls. Occupational glasses are often put into a light steel frame. We do not need to sell gold to industry. The frame must be exceedingly narrow, and the measurements made with her eyes focussed to her work distance, so that the interpupillary distance is for that work distance, not infinity, as ordinarily done. Otherwise, the girl would

have been looking through the edge of the lens instead of through the lens itself. A girl cannot do anything else except her work with this pair of glasses, so she leaves them at her machine. The further development of the use of occupational correction alone (where protection from hazards is not necessary) is going to be one of the major postwar developments in industry, in so far as eyes go. It is a field about which it behooves us to learn as much as we can as soon as we can. There are plenty of places where we need it for a war program; there will be even more places where we shall need it later on when management has time to analyze all the factors.

Many loopers and small parts assembly workers and near inspectors have an exophoria. Immediately we ask ourselves how much prism we need. Absolute rules and equations have not yet been established. By careful study of these phorias we gradually, by experiment and experience, determine how much prism base-in to incorporate in the prescription. Anything less than three degrees of prism is not worth anything. This can be a starter, from which to build up anywhere from 8 to 10 degrees. This is split between the two eyes, in lenses giving the necessary magnification, to see at that distance and to give comfort. The more plus, often the more prism is prescribed. Age, of course, makes a difference in the amount of plus and prism. These are many problems created for the optician in occupational correction, but these can be solved. Occupational correction was made for loopers and filament workers in England ten years ago. We here are just beginning to do it, and need to know a great deal more than we do, and there is urgent need for research and publication of attempts made. We need to experiment, to plunge into it, and to work with it.

There is an interesting and important relationship between distance acuity scores and production of hosiery loopers. The data from a group of girls in the looping industry was charted. The perfection of distance acuity was found to be inversely correlated with their production. The better they could see in the distance, the poorer their work was! These girls are mostly myopes and their distance acuity had absolutely no relationship with anything they did at a working distance of eight inches. You couldn't place them, you couldn't pick them, you couldn't correct them, you couldn't do

anything for that group of girls by merely recording their distance vision. Yet this is all that most industries record!

The effect of occupational eye wear on the production of learning loopers has also been studied by Professor Tiffin. Coinciding with the time that occupational glasses were provided, both the hourly earnings and the dozen pairs per hour picked up. The effect of occupational eye wear on the production of fine-gauge loopers is similar. Their hourly earnings and production of dozens per hour went up after correction. The turnover in this particular industry is enormous. These girls, placed without careful visual selection, are not able to do this type of work, and many won't be able to do it unless given proper occupational glasses.

The relation between near acuity scores and rate of production of radio tube assemblers is another instance studied. Excellence of near acuity correlates with production. Here, a record of distance acuity only would be useless.

I am going to take the liberty of saying a few words about screen testing techniques. The people we refract for industry directly, are those detected and screened out by mass testing. We all know that individual tests as made in our offices would be clumsy and time-consuming, and often impossible to conduct in an industry. The telebinocular is an excellent instrument and accurate, if we recognize its peculiarities. I do not know whether you know what those are, so I will mention a few of them. Most of you have seen the charts used with the telebinocular. These were originally designed for use in schools. They are almost impossible, and certainly very cumbersome, to use in industry.

The telebinocular tests for distance acuity are accurate. The depth perception test in the telebinocular is good enough to detect misfits for dangerous jobs. The percentage idea set-up is very bad and has unfortunately reflected itself so as to become almost a fixture in our thinking. Actually there is no scientific basis for a percentage scale in any instrument. There is an entity called instrument convergence, making it necessary to occlude one eye sometimes in determining acuity; for instance, a person can read no farther than 20/100 in the right eye. You occlude the left eye with a plain white card, and you will find that in about 30 or 40 per cent of the cases, that person will then come up to 20/20. This

latter record is the actual acuity of that eye. Neglect of this fact has produced the discrepancies noted between Snellen chart readings and those of the telebinocular. We can do much to straighten out such tangles when a plant uses this instrument. Muscle balance, on the Keystone record form, is not recorded in prism equivalents. We do know that when an individual is outside the range of "normal," that he does have a muscle imbalance. The color test is fair. Their near tests, except for the phorias, are conspicuous by their absence.

The other instrument possessing a battery of tests used for screening purposes, is the orthorater, which Bausch and Lomb designed specifically for industry. It has had the advantage of exhaustive checking, rechecking, with thorough validation of every single item in its scientific development. Extensive statistical analysis of its reliability has been made. The acuity test, which is a checkerboard, is a unique symbol shown to have the least amount of "guessing" potential. The near point tests for acuity and muscle balance are better, actually, than any individual test that we now have. All we have is the old-fashioned reading card held at any distance, without being really sure of where it is held. The mandate that only a specially trained lay technician be permitted to operate the instrument, and that the work and program be under the control of the medical department, is excellent. Recording of data is in code, by a technician trained not to know anything about the person as a patient. This, too, is an excellent feature. The fact is that it has proven to be a scientific "trouble-shooter" in many plants—this in addition to its use for testing applicants. As soon as there is trouble in any given department—too many rejects, lowered production, etc., that department is screen tested and the difficulties ironed out. The entire Service, including the use of the instrument, is rigidly laid down, and any violation or exploitation takes it away from that industry.

There is a vision screening instrument made by the American Optical Company. I have never seen it, but I understand it is being developed.

The new attitudes and the techniques of ophthalmology which have been given us, have created entirely new frontiers for us. These will change constantly as we meet new problems, and we must modify our practice to conform to these everchanging condi-

tions. A modern lathe is not what Dad used in the basement; an overhead crane is different from a gantry crane; a hooker is just a man who puts something on a hook; an expediter is not an assembly line operator. Shop vernacular is something for us to learn. Also we need to purge ourselves of our own academic vocabulary, and try not to use any 64 dollar words in the shops. They do not register; they do not click; they are going to confuse.

The rôle of an ophthalmological consultant is similar to that of a chemical laboratory. Management has a problem and says to us, "Here it is. It has to do with eyes. We want the answer." So we take ourselves out of our ivory towers and go out to find the answer to what they now call rightly their "visual bottlenecks."

The visual job analysis of any given plant is the best and only starting point, because it not only gives us the practical information but is a very thrilling experience for an ophthalmologist. Insist on seeing every listed job, or you may be caught. A conveyor line is a conveyor line—so I thought when I went through one plant. But one single girl on the line, out of hundreds, had a job in which she turned to pick something up and put it on a conveyor belt. The rest of them just stood there and did it; their eyes did not move, but this girl had to set a can in an exact position. She had a motion left, right; left, right, all day long. Her job was as totally different from the other conveyor jobs as if she were on another job entirely. There are no two lathes alike or no two assembly jobs alike. I feel that until we do learn to come out of our ivory towers and to leave behind us our "one and only way" of doing things, we cannot possibly meet the requirements of industry. We rarely use ordinary office techniques for industrial work. We have to meet industry halfway, which means meet lay management, employment directors, personnel directors, and safety men. We have to meet unions, believe it or not, individually through stewards, and in larger groups, to establish co-operation and to learn also. We need the backing of the union of a plant to put across occupational glasses programs. They have to understand what we are doing and why, and we have to understand what they are doing and why.

I think my own experience in industry has been worth a second college education to me. I have learned to give and I have learned to take. Our job is to accept our industrial assignment as it exists,

not as we would like to have it; to handle it with the least amount of disturbance to industry (because these folks are busy); to accept discomfort, noise, heat, dirt, danger, if necessary. And don't forget half of the industry works at night, and you will have to be there, too. Night workers do not want to be orphans.

It is up to us to provide practical answers, and not to aim to use industry to feed our private practice. Do not undertake to make a plant survey, then to put glasses on lots of people, to hand out office cards, to try to build up a practice. If we are to avoid creating boomerangs for industry and ourselves, we should work with industry as it needs us, not, necessarily, the way we do it in our private office. We can maintain accuracy and sometimes become even more skillful. To get the job done in the best way possible, to do it with eagerness and a desire for adaptability, is surely a major assignment. This is perhaps the Creed for the industrial ophthalmologist.

Ocular Lesions Due to Industrial Toxic Compounds*

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Introductory Comments

The growing use of poisonous chemicals in industry now presents one of the most serious hazards to the eyes of workers. This hazard is aggravated by the fact that thousands of men and women who are working with these compounds are wholly unaware of that fact, wholly unaware of the disease hazards to which they are exposed, and unaware of the steps they should take to guard against the harmful effects of these poisons. This is so because in many plants the poisonous chemical mixtures are usually trade secrets known to most of the employees who handle them only by some such designations as Solution B-3 or Compound C-4, the precise makeup of the material being known to perhaps only one or two persons in the plant. Since industry is being held responsible, more and more, for the effects of these toxic materials through their classification as compensable occupational disease hazards, there is an increasing necessity for the use of every known means to protect workers exposed to these poisons. In the meantime, it is the responsibility of every safety engineer, of every physician or surgeon having any industrial practice, and of every industrial nurse, to become familiar with all the poisonous substances used in their respective plants and to take all possible steps to protect the employees who are exposed to toxic compounds.[1]

According to Slyfield[2] more than 50 different toxic compounds are used in industrial processes, and at least half of these are more or less injurious to the eyes if handled continually or worked with at close range. Occupational diseases affecting the eyes are caused chiefly by chemicals and from the exposure to radiant energy.

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Absence of Reliable Statistics on Ocular Lesions Due to Industrial Toxic Compounds

Unfortunately, statistics concerning eye injuries are based on reports which, at best, are brief and often lacking in necessary information. Reports covering traumatic injuries are probably more accurate than the reports covering injuries or diseases of the eyes due to poisonous substances. The latter are more insidious and less spectacular in their action, but are just as disastrous. For this reason alone, the few statistics which are available on ocular lesions due to toxic compounds are on the conservative side. Consequently reported figures would tend to indicate that toxic materials either are not a big hazard or that reports covering such injuries are not filed with State Compensation Boards to the extent that they should be. In my opinion, the latter is probably the case. In discussing this troublesome phase of our problem, V. S. Karabasz, Associate Professor, University of Pennsylvania, in a speech to the Wood Products Section, of a recent National Safety Congress, stated:

> We know that the injuries reported are only a part of the total number of eye injuries which actually occur. Often the seriousness of an eye injury or the fact that it has or will result in the permanent loss of vision does not become apparent until long after the injury has occurred. More serious than the inadequacy of official records of eye injuries is the rapidly spreading use in industry of poisonous chemical and other deleterious materials which cause damage to the eyes. In many instances neither the workman whose eyes have been affected nor his physician knows that the worker has been exposed to poisonous fumes, liquids, or dusts.
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> In many other cases damage to the eyes develops after the worker has left the employment of the Company in which he knowingly or unknowingly, worked with or near poisonous substances. In either event the true cause of blindness or of serious damage to the eyes does not become a matter of record in the State Industrial Commission or in any other source of data concerning industrial injury or disease.

The industrial ophthalmologist should make a tour of the plant to learn the exacting and hazardous conditions under which the

men labor. Men complaining of headache or inflamed eyes should be sent in for consultation and examination.

Industrial Poisons Presenting Hazards to the Eyes

The continued introduction of industrial processes which necessitate the use of new poisonous substances has added to the number of toxic risks involving various forms of injury to the eye and its accessory nerves. The enormous increase in the production of dyestuffs and other chemicals since the last World War has augmented these risks considerably. The Bureau of Labor Statistics, United States Department of Labor, gives a list of fifty-two different toxic materials used in industrial processes; in at least half of the cases cited it is said that more or less serious injury to the eyes results from continuous handling of the poisons or continuous work in close proximity to them. Workers usually inhale these toxic compounds in the form of vapor, but the inhalation of dust may produce equally harmful results. Direct action of the poison through or on the skin is another method of entry; and sometimes the substance is admitted through food-stuffs, cigars, cigarettes, chewing-tobacco, etc., handled by the worker with hands from which the toxic material has not been completely removed.

In the United States the following substances are reported to be especially productive of serious results to the eyes: Ammonia, Benzol, and the other intermediates of the dye industry, Brass, Carbon Bisulphide, Dimethyl Sulphate, Hydrofluoric Acid, Lead, Methyl Alcohol, Methyl Bromide, Nitroglycerine, and Phosphorus. In Great Britain the principal substances that may be implicated are Lead, Derivatives of Benzene, Carbon Bisulphide, and Methyl Alcohol. These industrial toxic compounds or materials usually irritate the mucous membranes, giving rise to lacrimation and flashes of light before the eyes. Other results may be discoloration of the conjunctiva, disturbances of visual sense, retrobulbar neuritis, choroiditis, dilation of the pupils, photophobia, clouding of the cornea, diplopia from paralysis of the ocular muscles, amblyopia, protrusion of the eyes, contraction of the pupils, ulceration of the orbital bones, shrinking of the eyeballs, erosion of the cornea, transient blindness, progressive atrophy of the optic nerve, and permanent blindness.[4]

Resnick[3] lists these industrial poisons which affect the eyes, together with their principal effect or nature of injury:

ACETALDEHYDE—Irritation of mucous membrane of the eyes and respiratory tract.

ACETIC ACID—Inflammation of the mucous membranes, Conjunctivitis.

ACETONE—Irritation of the mucous membranes of the eyes and respiratory tract.

ACRIDINE—Irritation of the mucous membranes of the eyes and respiratory tract.

ACROLEIN—Irritation of the mucous membranes of the eyes and respiratory tract.

ALKALIES (Caustic Soda, Caustic Potash, Lyes, etc.)—Lesions of the conjunctiva and of the cornea.

AMMONIA—Severe irritation of the eyes, Conjunctivitis.

AMYL ACETATE—Irritation of mucous membranes of eyes and respiratory tract.

AMYL ALCOHOL—Irritation of eyes and respiratory tract.

BENZINE (Naphtha-Gasoline)—Visual disturbances, twitching of the muscles.

BENZOL AND ITS HOMOLOGUES—Conjunctivitis.

BERYLLIUM—Hyperemia of the cornea, Conjunctivitis, Blepharitis, Keratitis.

BROMINE—Conjunctivitis.

BUTANONE (Methylethyl Ketone)—Intolerable irritation of the eyes and nasal passages.

CALCIUM CYANAMIDE—Conjunctivitis, Ulceration of the cornea.

CARBON DISULPHIDE—Disturbances of sensation, particularly of sight.

CARBON MONOXIDE—Painfulness of the eyeball.

CARBON TETRACHLORIDE—Irritation of the eyes.

CHLORIDE OF LIME—Conjunctivitis, Lacrimation.

CHLORINE—Irritation of mucous membranes of eyes and respiratory tract.

CHLORODINITROBENZOL—Visual disturbances, Muscular twitching.

CHLORONITROBENZOL—Visual disturbances, Muscular twitching.

CHLOROPRENE—Irritation of mucous membranes of the eyes.

CHROMIUM COMPOUNDS—Irritation of the conjunctiva.

CRESOL (Cresylic Acid)—Irritation of the mucous membranes of the eye.

DIMETHYL SULPHATE—Lacrimation, Conjunctivitis and photophobia; total or partial color blindness.

DINITROPHENOL—Cataract.

DIOXAN (Diethylene Dioxide)—Irritation of the eyes.

ETHYL BENZENE—Irritation of the eyes.

ETHYLENE DIBROMIDE—Irritation of the eyes.

ETHYLENE DICHLORIDE—Irritation of the eyes.

ETHYLENE OXIDE—Irritation of the eyes.

FORMALDEHYDE—Irritation of the mucous membranes of the eyes, Conjunctivitis.

FORMIC ACID—Irritation of the mucous membranes of the eyes.

GASOLINE—Visual disturbances, twitching of the muscles.

HEXANONE (Methyl-Butyl-Ketone)—Intolerable irritation of the eyes and nasal passages.

HYDROCHLORIC ACID—Conjunctivitis.

HYDROFLUORIC ACID—Intense irritation of eyelids and Conjunctivitis.

LEAD AND ITS COMPOUNDS—Ocular disturbances.

LIME (Calcium Oxide)—Conjunctival and corneal lesions.

METHANOL (Methyl Alcohol)—Affections of sight including Amblyopia, Optic neuritis, Conjunctivitis, Mydriasis, Nystagmus, Visual hallucinations, Blindness.

METHYL BROMIDE—Visual disturbances.

METHYL CHLORIDE—Visual disturbances.

METOL—Inflammation of eyelids.

NAPHTHALINE—Vesicular spots on the cornea, developing into ulceration, Chorioretinitis, Conjunctivitis, Cataract.

NITROBENZOL AND OTHER NITRO COMPOUNDS OF BENZOL AND ITS HOMOLOGUES—Visual disturbances.

NITROGLYCERINE—Sudden blindness in one or both eyes, followed by headache; later restoration of vision.

NITRONAPHTHALINE—Visual disturbances.

NITROUS FUMES—Irregular pupil, Paralysis of the eye muscles, and Conjunctivitis.

OZONE—Irritation of the eyes and respiratory tract.

PARAFFIN—Irritation of the conjunctiva.

PETROLEUM—Irritation of the conjunctiva, Nystagmus, Disorders of the pupil, Mydriasis, Paralysis of the eye muscles.

PITCH—Conjunctivitis, Hyperpigmentation of the conjunctiva.

POISONOUS WOODS (Scented Wood, Iron Wood, Yellow Wood, Courbaril, Lignum Nephriticum, Bone Wood, Purple or Violet Wood, Red or Brazil Wood, Satinwood, Teak Wood, Greenwood, Cumaru Wood or Tonka, Cocus Wood, Black Ebony Wood, West India Mahogany, West African Boxwood, Maracaibo Boxwood, Magenta Rosewood, Tagayasan, Australian Mohwah Wood, Cocoloba, Sabicu and Others—See International Labour Office "OCCUPATION AND HEALTH," Vol. II, page 681)—Conjunctivitis, Irido-cyclitis, Keratitis.

PYRIDINE—Irritation of the eyes.

QUININE—Diminution of vision, Temporary blindness.

SULPHUR DIOXIDE—Irritation and inflammation of the mucous membranes of the eyes and respiratory passages.

SULPHURETTED HYDROGEN—Irritation of mucous membranes of eyes, Conjunctivitis.

SULPHURIC ACID—Severe inflammation of the mucous membranes and respiratory tract.

TAR—Ulcers of the cornea, Conjunctivitis.

TEA—Temporary blindness.

THALLIUM—Severe eye affections.

TOBACCO—Conjunctivitis, Amblyopia, Blindness (in connection with Alcoholism).

TURPENTINE—Irritation of the mucous membranes of the eyes.

Types of Lesions Due to Industrial Toxic Compounds

Being a superficial organ, the eye is directly exposed to dusts, vapors and gases of mineral, vegetable or animal origin, whether they are inert (acting mechanically) or active (acting through their caustic or septic characters). Lesions can be produced on the eyelids, the conjunctiva, the cornea and the lacrimal ducts. Diverse dermatoses, frequently occupational and often localized to the eyelids, deserve special mention, according to Coutela.[5] They have a peculiar chemical aspect due to the thinness of the skin and the extreme elasticity of the subcutaneous tissues. Some of these dermatoses are purely of toxic origin. Others, on the contrary, de-

velop only if there is an individual predisposition. The mineral elements may be of a well determined nature, such as lead (used in vinegar factories), mercury (used in conditioning fur skins), arsenic and sulphur (employed by vine sprayers). Any vapor can cause an ocular disturbance, even that of chromic acid, which gives rise to black staining of the cornea. Some other elements are of a more complex nature, such as the ammoniacal vapors, which affect scavengers and cause keratitis in workers in artificial silk, the chemical fertilizers, war gases and coal derivatives, which cause the dermatoses of coal miners. The lesions due to tar and resin can progress from common irritation to folliculosis and even to the malignant condition. It is generally admitted that external irritation can produce a precancerous state, which in some predisposed persons gives rise to a cancerous metaplasia. Added to this list of irritants are aniline and its derivatives (so frequently used in the manufacture of dyes), the solvents and cellulose varnishes (so widely used at present), methyl alcohol, powders and explosives (nitronaphthalin).

The vegetable elements are numerous: indigenous and exotic woods, flowers, hops, flours, vegetables, mushrooms, tobacco and pharmaceutical products, among which are podophyllin, which causes corneal and iridic lesions, turpentine, mustard, vanilla, lac and amber. Manchineel wood can provoke ocular disturbances with deafness in persons who work with it.[5]

Among the elements of animal origin which may effect vision are fur skins (removal of coarse hairs sometimes giving rise to visual disturbances, mostly through the medium of the nasal and postnasal cavities), hairs, wools, caterpillars and mother-of-pearl.[5]

Being highly vascularized and enervated, the eye is exposed to intoxications from lead, sulfocarbonate, and hydrocarbons such as benzene, trichlorethylene (causing involvement of the trigeminal nerve).[5]

Systemic Effects of Industrial Toxic Compounds

A large variety of industrial poisons give rise to transient affections of the eyesight, and some of them to permanent effects. Various toxic compounds may give rise to any one or more of these conditions, depending upon the strength of the poison and duration

of the exposure. Especially hazardous are the vapors of dinitrobenzol which is used in the manufacture of high explosives. Other substances which formerly produced much eye trouble have been eliminated from modern processes of manufacture or the operators are better protected by the wearing of respirators and goggles, as well as by the installation of exhaust fans. Such substances are iodoform, volatile coal tar products used in dyeing, and arsenic, formerly used in cosmetics and in the coloring of wall papers, artificial flowers, and paints.[6]

Prominent among the group of protoplasmic poisons which produce blindness through inflammation of the optic nerve, acute or chronic, are: alcohol, nicotine, carbon disulphide, trichlorethylene and the arsenical compounds. There is another group of internal poisons which produce blindness through other forms of inflammation and disease of the retina. Poisons of this group, instead of acting directly on the nerve fibers, affect the nerve secondarily through contraction of the small blood vessels of the nerve or retina, or through changes in the blood. In this group may be found lead, quinine, cocaine, sodium salicylate, silver salts, mercurial preparations, amyl nitrite and nitrous oxide gas.[7]

Toxic Amblyopias

Toxic amblyopia is a partial or complete blindness caused by a toxic substance which interferes with the function of the retina, the optic nerve or the more central optic pathway. Every new drug used in medicine and every new chemical used in industry is a possible cause of toxic dimness of vision so that this subject is constantly growing in scope. Victims are becoming more and more compensation-conscious and the ophthalmologist, in order to be fair to both employer and employee, must have a thorough understanding of this subject.[8] The most common substances which produce these effects are methyl or amyl alcohol, tobacco, iodoform, naphthalin, acetanilide, salicylic acid, atoxyl, arsenic and several drugs used as worm medicines, such as felix mas, santonin and pomegranate.[9]

Symptoms.—The first sign of toxic amblyopia, according to Benedict,[7] may be misty vision. Persons who have been exposed to poisons which effect the optic nerve or the retina as a rule complain

of temporarily disturbed vision as a first symptom. Recent color blindness is an early symptom of poisoning by either of the two groups listed by Benedict. Another common symptom is disturbed vision described as heat waves. Diminished sharpness of vision and general depression of the visual fields bring the victim to an oculist usually with a request for glasses. The characteristic changes in the fields are central, blind or partially blind area in the visual field and disturbances in the color field. There may be deficiencies in accommodation.

Classification of Toxic Amblyopias.—Carroll[8] divides toxic amblyopias into three groups. I—Those caused by poisons which produce cortical or central blindness, II—Those caused by poisons depressing the entire visual field, but more especially the peripheral fields, and III—Those caused by poisons depressing exclusively or chiefly the central visual field. He writes[9]:

> In cortical blindness there is a complete or almost complete loss of vision but the pupils react to light because the lesion is above the light center. One of the several causes of this condition is uremia (presence of urine constituents in the blood). Acute carbon monoxide poisoning as a cause of Toxic Amblyopia is a definite entity, but whether chronic carbon monoxide poisoning ever causes optic nerve damage is questionable. Carbon monoxide may be encountered from illuminating gas, fumes from automobiles, mine gas, furnace gas and sewer gas. Infrequently optic nerve injury may result following or during anesthesia; the latter condition is probably due to anoxemia. Complete blindness in a person suffering from acute alcoholism whose pupils react normally to light is probably due to acute alcoholic amaurosis (blindness occurring without any apparent injury to the eye). The prognosis is excellent and the patient is usually well in 24 hours. It is important to differentiate this type of poisoning from methyl alcohol amblyopia.
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> The second group of Toxic Amblyopias are those caused by poisons depressing the entire visual field but more especially the peripheral field. Barbiturates are usually a cause of amblyopia only when used in very large doses. A cause of amblyopia found among makers of artificial leather, rubber cementers, dry cleaners, engravers, lacquer makers and vulcanizers is BENZOL (Benzene). Dinitro-Benzol also may be a causative agent. Blood loss which occurs in patients whose general health is below par or whose red blood cell and hemoglobin are

markedly reduced sometimes causes this condition and treatment with transfusion is advisable. Toxemia resulting from burns may produce encephalopathy (disease of the brain), retinal hemorrhage and amblyopia. Carbon tetrachloride which is used both for cleaning purposes and as an anthelmintic (remedy for worms) may be a causative poison in some cases of amblyopia.

Methyl alcohol is a recognized cause of optic atrophy (a wasting of the optic nerve) as evidenced by the occurrence of this condition among painters who, when working in closed spaces, inhale the fumes of wood alcohol. The same danger exists for persons using wood alcohol in lamps. Children have been known to develop optic atrophy as a result of the external application of methyl alcohol in sponging. Taken by mouth the poison usually produces abdominal pain, vomiting and poor vision. Recovery in these cases is often followed by relapse.

In the third group of Toxic Amblyopias are those poisons which depress, exclusively or chiefly, the central visual field. Carbon disulphide, used widely in the rayon industry and also in the preparation of rubber, explosives, hides, insecticides and in the wool industries produces this type of amblyopia. It is usually accompanied by polyneuritis and other evidences of toxemia. Lead poisoning is found to be a cause of amblyopia in patients who are compositors, plumbers, storage battery makers and even in children who have eaten the paint from their cribs.

Thallium which is used by women having excessive hair growths as a depilatory and in industry as a rat poison usually produces peripheral neuritis preceding any visual disturbance.

Tobacco-alcohol poisoning is the most common and the most important Toxic Amblyopia seen in this country. It comes on gradually and occurs in an age group which may show some senile changes in the eye. It is important to differentiate this from macular degeneration (opaque spots on the retina) because the prognosis is good in tobacco-alcohol amblyopia and poor in senile macular degeneration. Recent research has shown that it is possible for patients with this condition to continue smoking and drinking and recover completely providing an adequate amount of vitamin B is taken.

Thompson[6] tells us that of eye diseases due to circulation of toxic materials in the blood, the effect is transient and immediate, causing double vision and dizziness (vertigo), acting mainly through the cerebral visual centers. In other cases the effect accompanies

symptoms of general systemic poisoning and is of the nature of chronic inflammation of the retina and optic nerve, causing partial or complete blindness. Some of the toxic metals afford striking examples of these symptoms. Thus double vision has been reported by one author[6] as associated with "Brass Chills" among those workers in brass foundries and brass polishing.

Principal Industrial Toxic Substances Injurious to the Eyes

Let us now consider in a little more detail some of the principal industrial toxic substances, which cause amblyopias and have other injurious effects on eyesight.

Lead.—Lead poisoning, which is one of the greatest toxic hazards in industry, is usually caused by the inhalation and absorption of its dust or fumes and may be acquired in a great many trades. Lead is particularly liable to injure the eyes of painters, file cutters, plumbers, electrotypers, typesetters and cleaners, pottery glazers, storage battery makers, paint grinders, and makers of red, white, orange and yellow lead, makers of lead pipe, tinsmiths, solderers.[6] The effects of poisoning by lead are very widespread in the body, but tend particularly to be localized in the nervous system. Inflammation of the optic nerve of one or both eyes is not uncommon in chronic lead poisoning and is associated with inflammation of the retina which may produce total blindness. Paralysis of the ocular muscles and dimness of vision have also been found in lead poisoning; recovery usually occurs.[10] Lead causes serious central, as well as peripheral, eye diseases, such as inflammation back of the eyeball, and paralysis. MacNalty states[4] that the prevention of visual impairment and blindness due to lead poisoning is a part of the prevention of lead poisoning and that where stringent precautions are enforced there will be few cases of blindness. In support of this statement he points out that in the past, cases of blindness due to lead poisoning were usually found in institutions for the blind, whereas at the present time there are practically none.

Arsenic.—This toxic material is used extensively in the manufacture of insecticides, artificial flowers, "Paris Green," in glass mixing, photoengraving, pickling and soldering, dyeing, pottery decorating, and in ore-refining. In the trades there have been reported cases of miners' arsenical poisoning with atrophy of the

optic nerve resulting. This has followed exposure to dust from the mineral known as sulpharsenide of cobalt. Arsenic is usually found in nature in the form of arsenical pyrites and apparently does not cause any injurious effects in this state. Medicinal or cosmetic use of forms of arsenic may cause eczema of the eyelids, conjunctival irritation and occasional toxic amblyopia and optic neuritis.[9]

Carbon Bisulphide.—Several cases of toxic amblyopia have been reported from the use of carbon bisulphide in the rubber industry. Carbon bisulphide is used in the curing of rubber, but its present use is not so extensive as in the past.[9] It is also employed in the rayon industry and in refrigerating plants, and produces a vapor which injures vision by affecting the retina or optic nerve. The uncontrolled use of carbon bisulphide acts quickly on the central nervous system, producing optic neuritis. Progressive failure of vision due to retrobulbar neuritis has been recorded. Other conditions reported are severe amblyopia, and ocular disturbances, (retraction of the visual field, and some disturbance of color vision) going on to amblyopia in a few cases; fatigue of accommodation has also been noted.[4] Carbon bisulphide is distinctly poisonous to the central nervous system, particularly to poorly nourished neurotic persons, and causes optic atrophy, neuritis and cerebral degeneration. Early symptoms as reported by Benedict[7] are disturbances of central vision, loss of appetite, diminution of visual acuity which in a certain number of cases develops early in poisoning and progresses without pain. A large number of eye injuries occur in the rayon industry to workmen in the spinning room where irritations are caused by a combination of mist containing about eleven per cent sulphuric acid in addition to the carbon bisulphide. British investigators found that, as the result of an isolated exposure of a few hours' duration, to a concentration of only one part of carbon bisulphide by volume in 3,000 parts air, severe headache and mental dullness or confusion usually results. If such exposures are of daily occurrence, the symptoms become increasingly severe with inflammation of the nerves, distorted vision and mental disturbances.[11]

Hydrogen Sulphide.—Hydrogen sulphide is an irritant and toxic gas which may be formed in the chemical industry in a variety of processes, as for instance in the manufacture of carbon bisulphide, of sulphur dyes, and of soda according to the LeBlanc process.

Exposure to hydrogen sulphide may also exist in the rubber industry and in the rayon industry where the viscose process is used. The toxic effects produced by hydrogen sulphide vary considerably with the concentration to which a person may be exposed. Its irritant effect, however, is most conspicuous on the membranes of the eye and it may result in very painful conjunctivitis with marked injection, lacrimation, photophobia, and occasionally in defects of the cornea. It appears that under certain conditions such defects may be the first and main symptom, leading to foggy vision and other disturbances such as colored rings around the lights, which may be due to interference phenomena. The defects represent punctated erosions of the cornea[12] which in severe cases may flow together and in which the epithelial layers are loosened; this condition may be preceded by a period of scaling.[13] It is of great importance that all those handling hydrogen sulphide or who may be exposed to it be informed regarding its toxicity and potential dangers. It is also essential that, in all operations where hydrogen sulphide may contaminate the air, the concentration of 20 parts per million or less be maintained by proper exhaust ventilation, preferably at the site of the formation of the gas. Conjunctivitis resulting from exposure to hydrogen sulphide may be treated by instillation of 1 drop of olive oil which is said to alleviate the pain. In severe cases, administration of 3 to 4 drops of 1:1,000 solution of epinephrine every 5 minutes, for three or four instillations, may prove helpful. If the pain becomes very severe, local anesthetics and hot or cold compresses may be of benefit.[14]

Carbon Monoxide.—Carbon monoxide produced by the imperfect combustion of gasoline may be so prevalent in garages and automobile repair shops as to produce disturbances of the optic nerve and the retina.[15] The literature on carbon monoxide asphyxia contains a fair number of reports of permanent damage to vision. Drinker[16] has found that as a rule, serious eye injury requires severe poisoning, that is, poisoning in which there is a long period of unconsciousness. But there are rare cases which are exceptions to this rule. We are told that in most cases of visual disturbance following carbon monoxide asphyxia, the lesions are in the vital part of cells of the different ocular nerves. The effects may be permanent, as in the case of other cerebral damage due to carbon monoxide,

or they may be quite transient. When permanent, they are to be distinguished from hysterical phenomena, so often found after mild poisoning, by the presence of nervous or mental symptoms indicating damage to the nervous system, or by definite lesions in the eyegrounds.

Methyl Alcohol.—Methyl alcohol or "Wood Alcohol" is extensively used as a solvent for shellacs, varnishes, and finishes in the manufacture of many common articles, and in the preparation of perfumes, paint removers, denaturing spirits, production of coal tar colors, as a solvent for aniline dyes, and in toilet preparations. The inhalation of its vapors for a long period of time may cause changes in the optic nerve, leading to partial or total blindness. The ingestion of methyl alcohol is more apt to produce blindness from atrophy of the optic nerve.[9] Amblyopia, which is bilateral, occurs within a few hours of exposure or sometimes after several days. Often transient at first, it recurs and may be followed by complete and permanent blindness. Before actual blindness occurs there may be pain and tenderness on pressure of the eyes, dilated pupils, fogginess and blurring of the vision, diplopia, or ptosis. There is an increasing contraction of the visual fields for form and color, congestion of the sclera, pallor of the disk, central scotoma, and much reduction of visual acuity. The exact etiology of the atrophy present is still in question.[4] Methyl alcohol is soluble in such lipoid substances as are found in nerve tissues, and after death the brain retains a large percentage of this alcohol. A highly differentiated nerve substance like that of the optic nerve is therefore particularly liable to be affected by it.[6] It has been thought for a long time that wood alcohol attacks the eyes especially, but recent researches have demonstrated that this is not a special attack on the eye but that the eye is merely indicative of the response that goes on in the brain and other tissues, and that the blindness produced or the effect on the vision is simply discerned more readily. There is nothing so outstanding or dramatic as any effect on the eyes.

Derivatives of Benzene.—The chief of these benzene derivatives are dinitro-benzol and trinitrotoluene. Dinitro-benzol, used in the manufacture of aniline dyes and the production of high explosives, produces a distinct toxic effect on the vision similar in many respects to that caused by carbon bisulphide. Its effects are found

in varying degree in all those who suffer periodically from subacute attacks of poisoning. Susceptibility may aggravate the symptoms, but no worker can claim perfect immunity. It is highly toxic and affects the general system of the body chiefly through absorption by the skin, or by inhalation. Optic neuritis may be a concomitant of such poisoning, but there is no record of the eyesight, being seriously affected by dinitro-benzol in Great Britain since 1914.[4] Comparatively few complain of any impairment to their eyesight, but probably about one in ten are unknowingly affected. The use of dinitro-benzol has been responsible for the inception of toxic amblyopia in certain cases of exposed workers.[9] Snell summarizes his conclusions regarding the effects of dinitro-benzol thus:[17]

> Failure of sight, often to a considerable degree in both eyes, concentric contraction of the visual field, within many cases a central color scotoma, some blurring, never extensive, of the edges of the disc, and a varying degree of pallor of its surface.

In all cases absence from exposure removes these symptoms in a varying length of time, and usually a restricted exposure will alleviate them.[17]

Trinitrotoluene is much used in munition work during war time, but no certain cases of optic neuritis due to its employment have been reported.[4]

Aniline.—There have been complaints of irritation of the eyes and loss of vision from the inhalation and absorption of aniline material in the manufacture of coal-tar products and in dye factories.[9]

Volatile Toxic Substances.—Many volatile substances when they reach the blood through absorption may seriously affect vision, acting either directly upon the structure of the eye or affecting it through cerebral deficiency by the quality or quantity of blood in brain vision centers. Vapors of some of the volatile solvents are absorbed through the lungs and cause damage to the body, the eyes included. Any substance that will cause swelling due to accumulation of a fluid in the tissues of the brain and other organs will cause a similar response in the eye tissues. This may cause dilation or constriction of the blood vessels and if prolonged or repeated frequently may result in damage to the eyes. The eye is the only

window through which we can actually look inside the body and see the physiological changes which are taking place as the result of the poisonous material, not only in the eye, but elsewhere in the body, particularly in the brain. It is not uncommon for some people to be extremely sensitive to amines, aldehydes, mercaptans, and thio-cyanates, and, therefore, it might be well to be alert to the possibilities of hyper-susceptibility. Many of these compounds have an irritating effect on the eyes.[18] Cases of more or less marked loss of vision have been reported. In some of these, there was loss of color sense without visible change in the eyeground. Trichlorethylene must also be added to the volatile substances used in industry which have a selective action on the optic nerve. An indirect form of injury to the eye is noted by German factory inspectors, who have found corneal ulcers resulting from a foreign body in the eye which the workman had not been aware of because the cornea was rendered anesthetic by the fumes.[19]

Occupational Keratitis and Corneal Dystrophy

Keratitis may be defined as an inflammation of the cornea. Corneal dystrophy is a condition in which there is defective or faulty nutrition of the cornea. Occupational keratitis as well as several other forms of keratitis are treated by Fuchs[20] under diseases of the conjunctiva, and occupational conjunctivitis is defined as "an acute conjunctivitis found in certain industries where irritants—acrid vapors, liquids, or dustlike particles—get into the eyes either by accident or as part of the day's work." Under conditions allied to corneal dystrophies are further described changes produced in the deeper layers of the cornea by the continuous action of various substances, such as lime, lead, silver, nitronaphthalin and iron (siderosis). Occupational superficial punctate keratitis is an inflammation marked with points or dots on or near the cornea produced by occupational exposure and has been found among workers with lacquers in the furniture and metal industries, in mushroom canning, among workers in the straw hat industry and in agricultural workers on reclaimed marsh lands in California. Rankine[21] who reported on 1,598 workers in the acid house in the rayon industry, listed the symptoms as blurred vision and halos, grittiness, abnormal intolerance of light, discharge of tears, eyelid

muscle spasm, aching back of the eyes, and headaches. Burning and stabbing pains increase toward the end of the day and working week and the symptoms are most marked during the winter months when the ventilation of workrooms is poorest. All writers stress evidence of individual predisposition in the form of frequent recurrences in some persons and immunity of other neighboring workers.[22]

The outstanding offending agents appear to be hydrogen sulphide, principally in the rayon and sugar industries; also mines and tunnels, benzol and similar solvents and diluents of varnishes, shellacs and lacquers. Many writers, such as Klein[23] and Büchlers[24] stress the effect on the cornea of the drops scattered by spinning and spraying rather than the gases involved, in artificial silk industrial processes, as the factor responsible for the eye conditions found. According to McDonald[25] hydrogen sulphide containing droplets of acid bath are responsible for keratitis among the workers in the rayon industry. He found the condition more marked in damp weather and stated that a concentration of ten parts per million is permissible. Other of the important agents considered in the textbooks and in the literature are hydrogen fluoride, tar pitch, mercury and silver sublimate, certain kinds of wood and lead nitrate. The victims all get well with change of occupation, and there is complete return to health in from seven to ten days.[22]

Davidson[22] asserts that true occupational dystrophy such as is reported in textbooks and in the literature, has not been observed. Cases of dystrophies as after-effects of accidents have, however, been encountered. For example, examinations prove that a degenerative process goes on in the cornea with lime incrustation in the course of years in connection with lime burns. These manifestations may be delayed and present problems in the differential diagnosis between injury and disease.

Conclusion

One of the popular fallacies concerning eye hazards is that of regarding some operations as involving so-called "minor" hazards, thus calling for minor protection. It should be the axiom in safety practice that there is no such thing as a minor hazard, insofar as the eye is concerned; for at any moment an innocent enough operation may develop a major risk. These symptoms are warnings

that something should be done promptly: headaches; eye aches; tired feelings on using the eyes; blurred vision; inflammation or soreness of eyes or lids; watery eyes; swelling, puffiness, or drooping of lids.

Ocular defects, impaired vision due to effects of toxic industrial compounds and organic diseases of the eye not only reduce vision, both central and peripheral, but by causing distortions, blind spots, illusions, etc., handicap the worker's control of a large percentage of his physical actions.

It is a shortsighted policy to do nothing to safeguard vision because the ideal facilities are not at hand. If the services of an ophthalmologist are not available, then the combination of industrial physician and optometrist may be found satisfactory or, lacking these, a nurse trained in eye work can be of great value if the limits of her training and responsibilities are understood. Obviously, all reasonable effort should be made to reduce exposure to hazards affecting the eye by the installation of necessary facilities for preventing and eliminating atmospheric contaminants and by the provision and required use of effective protective devices such as goggles and masks. It is also neither kind nor safe to permit a man with an active ocular disease to jeopardize the safety of himself and those about him by attempting to perform work which requires accurate visual supervision. It is the responsibility of every safety engineer, of every physician or surgeon having any industrial practice, and of every industrial nurse, to become familiar with all the poisonous substances used in their respective plants and to take all possible steps to protect the employees who are exposed to these poisons.

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Industrial First Aid in Chemical Injuries of the Eye

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I SHOULD like to begin this discussion by reading one paragraph which I think represents the consensus of those full-time industrial physicians in the large industrial plants, where there are well planned and operating medical departments:

> Of all the commonly occurring injuries seen in industrial practice, those to the eye carry the most serious potentialities for permanent, serious disability. Proper early treatment, however, can usually greatly minimize or prevent such a result. It must be re-emphasized, therefore, that all but the most trivial of eye injuries should be promptly referred to an ophthalmologist if the welfare of the employee, the pocketbook of the employer, and the reputation of the industrial physician are to receive maximum protection.

There is a crying need in most small industries for "standing orders" that can be carried out by the nurse in industry. This need is accentuated by the really remarkable accomplishments of your society. You have devoted much time and effort in getting across to the layman as well as the nurses and physicians in industry that in the event an irritant chemical has entered the eye, the first objective should be the immediate removal of the offending agent. This can best be accomplished by immediate irrigation of the eye with copious quantities of clean running water. The patient should then be sent directly to the Plant Medical Department. If there is an irritant reaction or a burning sensation from the material, the patient's eyes should be flushed with water immediately at the site of the accident.

Traumatic injuries should not be touched at the site of the injury but the patient should be sent directly to the Plant Medical Department.

After the above first-aid treatment at the scene of the accident,

the following treatment should be carried out in the Plant Medical Department:

(1) Test reactions of the contents of the conjunctival sac by lightly touching indicator paper to the mucous membrane surfaces of the lower fornix. (Litmus paper is poor because a large pH shift is required before a color change from the blue to red or from red to blue occurs. Alkacid test paper or pHydrion paper is much better because definite and easily recognizable color changes take place with a pH shift as small as 0.2 of pH unit. Nitrazine paper is satisfactory for acid burns, but poor for strong alkali burns.)

(2) Local anesthetic should be placed in the eye.

(3) Thoroughly wash the eyebrows and tegument surrounding the eye in order to remove all residual chemical or foreign particulate matter which may be present. This may be done while the anesthetic is taking effect.

(4) Copious irrigation of the eye with saline or distilled water should be immediately instituted.

(5) Place two drops of a 2 per cent sodium fluorescein solution on the eye, allow a minute for staining of any denuded area, and then rinse with physiological saline.

(6) Examine the eye under a Hague cataract lamp, or a strong beam of light, with the aid of a magnifying lens. This should be followed by slit-lamp examination.

(7) If there is still discomfort after the above procedure, local anesthetic may again be placed in the eye, then followed by irrigation.

Definitive Treatment for Acid Burns

(1) Cold lavage compresses, changed every 3 to 5 minutes for a period of 1 to 3 hours. Mild reducing or oxidizing solutions are recommended. While the duration of this irrigation will depend upon the cause, type, extent and severity of the injury, the irrigation should always be continued until there is a maintained neutral reaction upon testing the secretions in the fornices.

Note.—Most acid burns of the eye are instantaneous and not progressive, and consist essentially in the precipitation and perhaps denaturing of the tissue proteins. The severity of the burn seems to depend upon the pH of the acid, the degree of dissociation, the character of the anion, and, most important, the time that the acid remains in the eye before it is diluted and removed. As a general

rule, acid burns heal more rapidly and are much less difficult to handle than alkali burns.

(2) Local anesthetics generally used are pontocaine, butyn, holocaine. Most uncomplicated cases of acid burns require a local anesthetic, an oily lubricant, and some non-irritating bacteriostatic substance, such as penicillin or streptothricin in the cul-de-sac during the first 24 hours. In every burn of the eye a symblepharon may develop if two denuded mucous membrane surfaces are approximated and immobilized. Liberal quantities of such ointments, together with twice daily compulsory inspections, will prevent many a symblepharon.

(3) Dark glasses, atropine, eye pads—the advantages to be derived from any or all of these, when needed, should not be overlooked.

As a general rule, acid burns are not progressive and secondary treatment is largely symptomatic. Additional measures include the use of the following:

a. Boric acid and ophthalmic ointment, together with an eye pad, or the instillation of sterile castor oil, cod liver oil or olive oil. (These will alleviate the symptoms which usually accompany acid burns, as well as promote regeneration of the corneal epithelium.)

b. Removal of any discharge from the fornices by instillation of a mild silver protein 10 per cent solution followed by copious irrigations of boric acid.

c. Butyn and metaphen ointment. (Rapid but short-acting local anesthetic.)

d. Metycaine and merthiolate (slower than butyn but more prolonged action).

e. Holocaine (phenacaine) 1 per cent should be used. (Cocaine should not be used in view of the fact that it delays healing, softens and swells the cells, and produces further damage to the epithelium.)

f. Secondary infections are best treated with penicillin ointments, 250 units of the dry powder suspended in 1 cc. of mineral oil.

Definitive Treatment for Alkali Burns

(1) Cold lavage compresses, changed every 3 to 5 minutes for a period of 1 to 3 hours. Mild reducing or oxidizing solutions are recommended. While the duration of this irrigation will depend

upon the cause, type, extent, and severity of the injury, the irrigation should always be continued until there is a maintained neutral reaction upon testing the secretions in the fornices.

Note.—Since alkali burns, unlike acid burns, are nearly always progressive, there is a great deal that the first aid as well as definitive treatment has to offer, and especially does this apply to the benefits that will accrue from the continued irrigations with a mild buffer solution. In many cases it is advisable to keep these irrigations up for one-half hour or more.

(2) Cold compresses together with penicillin or streptothricin are useful in inflammatory affections of the conjunctiva. Edema of the lids and chemosis, so frequently seen in these burns, may be measurably reduced by a small cotton ball saturated with buffer solution, covered with a 4 x 4 inch gauze compress moistened in the cold buffer solution placed over the lids, or by the dry method (ice-bag), which, as a rule, is less painful to the patient if the skin of the face and forehead is protected. Ice should never be applied to the lids directly.

Note.—Since strong alkali solutions penetrate deeply into the cornea within a very few seconds, a resultant corneal ulcer may be anticipated by the swollen corneal stroma with leukocytic infiltration. Frequently the cornea temporarily becomes less cloudy, but on the fourth to eighth day a pannus of blood vessels enters the cornea from the limbus, over which the corneal epithelium does not regenerate. In the event the cornea or conjunctiva is severely burned and appears white or gray, a symblepharon or corneal lesions, including adhesions between the lid and the eyeball, may develop.

(3) Dark glasses, atropine, eye pads should be used as required.

Additional routine measures in the treatment of alkali burns of the eye should include:

a. Instillation of atropine sulfate—1 per cent ophthalmic ointment or solution (the solution when irrigation, the ointment when oil is used).

b. Careful twice-daily inspection for adhesions between the lids and the globe. (A glass rod—cocktail stirrer—is very useful in breaking these adhesions.)

c. Liberal quantities of boric acid ointment placed between the

globe and lid to act as a barrier and serve in prevention of further adhesions.

d. Any discharge removed from the cul-de-sac by the instillation of a mild silver protein 10 per cent solution, followed by copious irrigations of boric acid.

e. Penicillin or streptothricin ointment, 250 units per gram of petrolatum, is a very useful agent in preventing secondary infections.

Definitive Treatment for Superficial Foreign Bodies in the Eye

It is of the utmost importance that the patient be placed in a satisfactory position which will allow for perfect comfort and relaxation on the part of the patient as well as on the part of the physician.

These objectives can best be accomplished by the following:

(1) Place patient in reclining position.

(2) Administer local anesthetic, butyn, or pontocaine.

(3) The physician should sit at the patient's head. His elbows should rest on the cot, with his hands and face in such a position that he is looking and working from above downwards over the globe of the patient's eye.

Note.—There is much less danger of causing damage to the eye in this position than in having the patient sitting in a chair and the operator working from a sitting position in front of the patient. Working from in front, a slip of the physician's instrument is almost certain to result in puncturing or otherwise severely damaging the patient's eye—working from above, a slip is likely to give only a tangential injury of much lesser severity.

(4) No patient should be allowed to leave the dispensary after a foreign body has been removed from the cornea or conjunctiva without first placing onto the bulb a couple of drops of 2 per cent sodium fluorescein solution or aqueous mercurochrome. Frequently in cases where there is a history of a foreign body but no foreign body is found, fluorescein instillations will reveal scratched surfaces of the cornea which are missed without the staining aid.
I have found the Hague cataract lamp to be of great assistance since it furnishes a source of ultra violet light which may be used together with fluorescein to produce the fluorescent phenomenon on the stained cornea.

Ophthalmological Guidance for Nurses in Industry

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UNDER medical direction and with proper guidance by ophthalmologists, the nurse is an important factor in a sound program for care and protection of eyes in industry. However, responsibilities for eye care delegated to nurses differ markedly from those which nurses are expected to meet in any other branch of nursing, and are often far greater than in hospital nursing or in any of the other public health nursing fields. Furthermore, nowhere in their nursing education do nurses receive an adequate preparation for many of the duties relating to the protection of eyes which they are expected to undertake in industries.

As is well known, few schools of nursing are able to give experience in the nursing care of patients with eye conditions to all of their students and must limit their instruction to ophthalmological lectures. Even where available, experience in ophthalmic nursing is usually quite limited and seldom do student nurses have any practice in personally handling an emergency eye case or in giving vision tests. No one can be more aware of these deficiencies than the nurses themselves and they are looking to ophthalmologists for guidance and help in determining the scope of eye services the nurse should render in industry and in learning how to perform them competently.

What are some of these duties? A recent study of nursing services in 924 industries found that nurses' functions range from "strictly first aid" to "an all-inclusive program" of health promotion in industry as currently conceived. This consisted of care and treatment of injured and ill workers, assistance in medical examinations including tests of vision and in plant sanitation, participation in health and safety education and in welfare activi-

ties, visiting nurse services in the homes for ill workers and, in some cases, for their families.

The scope of the responsibility of nurses for eye care in industry is further indicated in two recent publications—"Nursing Functions in Industry"[1] and "Nursing Care of Eyes in Industry."[2]

It is a fundamental principle that nursing service is rendered only under a licensed physician, but in the survey already referred to 77 per cent of the nurses were found to be in plants employing physicians only part-time or on call. This makes written standing orders, approved and signed by a physician or panel of physicians, imperative. Furthermore, even where the nurses work under full-time medical direction they should be provided with written outlines of procedure approved by the medical director. Such of these standing orders and routines as relate to eye care should be subject to review by consultant ophthalmologists. Most plant physicians would undoubtedly welcome such assistance in guiding nurses and first-aiders working under their direction.

While in many of the larger industries nursing service is available in the emergency departments during all the working hours, in others first aiders cover the emergency room except during the day shift. This service should be under the plant physician's or nurse's direction and should also be subject to ophthalmological guidance. Standing orders for emergency care should vary in relation to the abilities of the person who will give the care.

However, in rendering such services ophthalmologists need to be familiar with the eye problems and the factors controlling the scope of the nurse's duties in the industry in question. In the survey of nurses' functions in 924 industries, already referred to, a number of factors were found to determine the type of services rendered by nurses in an industry. Important among these were attitudes and policies of management in relation to health services for workers. These may either put undue restrictions on the nurses' duties or, conversely, nurses may be urged to undertake activities which do not lie within their proper sphere. It was also found that the administrative set-up of the medical department greatly influenced

[1] *Nursing Functions in Industry.* National Organization for Public Health Nursing, 1790 Broadway, New York 19, 1943.

[2] *Nursing Care of Eyes in Industry.* National Society for the Prevention of Blindness, 1790 Broadway, New York 19, 1944.

the scope of nursing activities. Here it is of interest to note that nurses' responsibilities are usually far greater under part-time or on-call physicians than under full-time medical directors. This is natural but there is, of course, considerable danger in this situation, particularly when it is remembered that in the absence of a well-organized medical department the nurse may be under considerable pressure to exceed her proper rôle. Obviously a nurse's personal qualities, her professional preparation and the type and extent of nursing supervision, together with medically approved written orders, are the greatest safeguards in such situations.

Personal conference between consulting ophthalmologists and nurses in industry is desirable, even where the nurses are under full-time medical direction. Obviously there should be close co-operation between the medical director and the ophthalmologist, but unless the ophthalmologist knows the nursing staff or the supervisor, he cannot adequately appraise the extent of responsibility he can safely and wisely delegate to the nurses. This is greatly facilitated where there is a well-qualified nursing director or supervising nurse with whom he can confer and to whom he can teach the procedures he wishes employed, and who in turn will teach them to her staff. Such guidance should be continuous. It is not enough to set up standing orders, outline and teach procedures. As new problems and methods arise, or situations and personnel change, the way should be open for such additional contacts between the ophthalmologist and the nurse as are needed.

An example of the need for guidance was seen in a plant recently visited. Here a substitute nurse had replaced the previous nurse, who had gone into war service. There were no standing orders for eye care, and the only facilities for the care of eye emergencies were eye-cups, a commercial eye wash, boric acid and butyn, the latter in a dropper bottle.

Nor should the ophthalmologist's guidance be limited to procedures for emergency care. In co-operation with the medical director or plant physician, consideration should be given also to the nurse's place in vision testing, the type of tests to be used, records to be kept, and interpretations to be made by nurses where such are included in her functions. As workers often ask nurses questions not only about their own eye problems but also those of their

families, nurses have tremendous opportunities for public education in eye health and safety. However, here again nurses need help, as their knowledge of this subject is often limited. Written instructions for all of these activities are urgently needed at the present time when so many nurses are entering industrial service for the first time.

Essential to the rendering of eye service is the necessary equipment. Nurses are often unfamiliar with much of this equipment and the sources from which it can be purchased. Nor do they always realize the importance of adequate standardized equipment and facilities. Unfortunately, they often hesitate to ask for the equipment that they need, as they are not sufficiently impressed with the importance of good equipment, and try to get along on much too little. The consulting ophthalmologist should be prepared to advise and assist the nurse or medical director in interpreting to management the fact that it is an economy in the long run to make adequate provisions for eye care, vision testing, and for education about eye health and safety.

If ophthalmologists are to help guide the eye program of nurses in industry, they must develop an over-all view of its place in relation to other aspects of health protection for which these nurses are responsible. It will ill serve sight conservation if, for example, the nurse gives so much time to vision tests or the goggles program that the venereal disease program suffers. Nor should the consulting ophthalmologist encourage nurses to take on responsibilities in relation to eye care which they may be perfectly capable of fulfilling but which more properly lie within the scope of some other department. If such a department is not ready to undertake its full duties in relation to eyes, it should be built up to the point where it can. I am thinking particularly of the goggles program in which the nurse can, of course, co-operate, but the major responsibility for which should rest with the safety department. Equally, in a program for studying the vision of candidates for jobs, although vision testing may be within the scope of the nurse's duties, appraising the nature of visual tasks definitely is not. An enthusiastic nurse, especially in a plant with part-time medical direction and perhaps a limited safety department, often is inclined to take on these responsibilities because she realizes their importance and sees no other way to get them done.

Workers tend to bring many problems to the nurse, especially in small plants. Thus the nurse who receives frequent complaints about poor lighting or so-called "eyestrain" is often tempted to try to make lighting surveys. This too lies outside the nurse's proper scope, although she should be alert to lighting problems in her tours of the plant and should report complaints and faulty conditions to the proper person. Of course, she should know where to get expert advice on this highly technical subject, just as she should be familiar with national, state and local resources for other aspects of eye care.

Here again ophthalmologists can be of great assistance. Many of the nurses coming into industry are not familiar with these resources, either because their previous work has not required such knowledge or because they are new to the community. The ophthalmological consultant should be in a position to help the nurses build up a file of resources for eye care, and for proper equipment.

To sum up, ophthalmologists can and should guide industrial nurses in eye care, and such assistance is urgently needed. This is a challenge both to the individual consultant and to the ophthalmological sections of medical societies which should have a part in developing the standards for industrial health programs and leadership in the standards for eye care in industry. The Standing Orders for Nurses in Industry prepared by the Council on Industrial Health and published in the August 28, 1943 issue of the *Journal* of the American Medical Association is a good beginning. These, however, are limited to emergency procedures. The section on eye injuries, while covering essential points, does not adequately indicate the equipment and specific techniques to be used. Expanding this type of material to define nurses' functions in eye care in industry and to give detailed directions would greatly enhance the co-operation nurses could give in the industrial eye program. Such standards, however, should be largely suggestive, nurses in particular industries receiving direct guidance from the consulting ophthalmologists to whom the workers are referred. While nurses can agitate for such service from ophthalmologists, it is the ophthalmologists themselves, through their organizations and as individuals, who must convince their colleagues, who are industrial physicians, as well as management, that such service is not only highly desirable but essential to the welfare of the workers.